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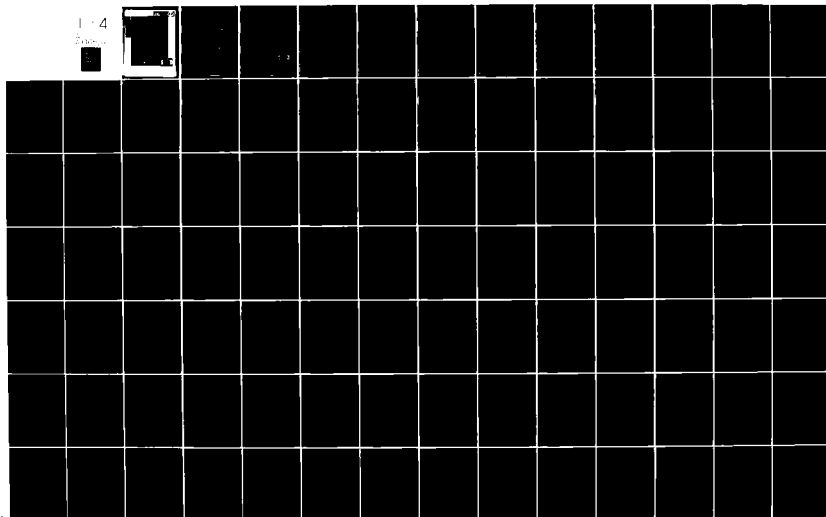JUN 79 R A WALKER
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METHODOLOGIES FOR ESTIMATING AND COMPARING

SOVIET DEFENSE EXPENDITURES

by

Robert Allan Walker

A Dissertation Presented to the

FACULTY OF THE GRADUATE SCHOOL

UNIVERSITY OF SOUTHERN CALIFORNIA

In Partial Fulfillment of the

Requirements for the Degree

DOCTOR OF PHILOSOPHY

(Business Administration)

June 1979

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defense spending and the policy issues involved when comparing
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indices can provide useful information concerning the resource
implications of defense spending.

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GLOSSARY OF TERMS AND ACRONYMS

AEC	Atomic Energy Commission
CER	Cost-estimating relationship
CIA	Central Intelligence Agency
DOD	Department of Defense
Durables	Machinery and equipment of all types
ERDA	Energy Research and Development Agency
FD	Final demand--output allocated to investment, consumption and defense
FNE	The Financing of the National Economy component of the USSR State budget
FY	Fiscal year
FYP	Five-Year Plan
GKNT	State Committee for Science and Technology
GNP	Gross national product
Gosplan	USSR State Planning Commission
GVO	Gross value of output--intermediate products and final demand
IO tables	Interindustry matrices
Intermediate products	Inputs to final demand
MB	The machine building sector of USSR industry
M&MW	The machine building and metal working sector of the USSR industry
MOD	Ministry of Defense
MW and repair	The metal working and capital repair of equipment subsectors of M&MW
NII, OKB, SKB	Soviet acronyms for scientific research institutes, design bureaus which perform most RDT&E in the USSR
NIR	Soviet acronym for Scientific Research Work, the equivalent of applied research and exploratory development in the United States

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N.Kh.	Annual statistical handbooks published by the TSU
NMP	Net material product (USSR National income)
NS	National security
NSE	National security expenditures
OKR	Soviet acronym for Design--Development Work, the equivalent of engineering and system development in the United States
O&M	Operations and maintenance
Producers' prices	Wholesale price of the factory
Purchaser's prices	Prices paid by final users of a (FD) product-- includes transport and distribution costs and taxes (if applicable)
R&D	Research and development
TRD&E	Research, development, test and evaluation
r/$ ratio	Ruble/dollar ratio
TSU	USSR Central Statistical Directorate
VUZ_y	Higher educational institutions

CHAPTER I

STATEMENT OF THE PROBLEM

"Power," claimed former Chinese Chairman Mao Tse-Tung, "comes
from the barrel of a gun." To this, the Soviet Union adds economic,
political, and qualitative elements to produce a power equation, the
"correlation of forces." Even in the more expanded definition, military
capability remains the key element in analyzing international power
politics.

Power, including military power, remains the final response in
dealing with potential conflict. The spectrum of available responses
is, however, tempered by the knowledge of the instruments of power
available to the potential adversary. Thus, the nature of the military
forces which might be arrayed against the United States is as integral
a part of the U.S. power equation as the physical characteristics of the
U.S. force.

The knowledge of the spectrum of power available to each side
is never absolute, except in total conflict. Likewise, the value of
military power is not absclute. Its role, short of actual conflict,
and its efficacy in a conflict can only be measured relative to one's
potential opponents. Nations obtain an indication of the potential
results by analyzing the objective and subjective characteristics of
national power possessed by each side.

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The key problem, then, is how to measure the elements of national power and how to compare those elements between various countries. In the subset of military powers, the key protagonists are the United States and the Soviet Union. The measurement and comparison of military capability between these two countries influence policy decisions in both the national and the international arenas. Defense spending is often considered the keystone in making such a comparison. Aggregated over time, it yields the total force structure. This element, defense spending, and its implications form the fundamental structure of this dissertation.

Background

The Soviet State budget includes only a single line entry for defense. The amount of that entry bears little resemblance to the observed Soviet force or to its changes over time. For a policy maker to correctly include the characteristics of the Soviet military force in his decision process, alternative estimation methodologies must be used.

By far the most sophisticated and detailed of the present methodologies is the Direct Costing or "building block" approach of the U.S. Central Intelligence Agency (CIA). Direct Costing was developed in the early 1960s because of the perceived inadequacies in the published Soviet defense budget. It was designed to be totally independent of that budget.

Direct Costing is based on the observed numbers and characteristics of Soviet Weaponry. Indirect estimation (e.g., based on a U.S.

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analog) is used to supplement direct observation. Non-hardware costs, such as operations and maintenance, are estimated in a manner similar to the pricing of Soviet hardware. Direct Costing also provides an estimate of the ruble value of Soviet defense expenditures by applying ruble/dollar ratios to the elements of the dollar based estimate. Operationally, Direct Costing provides a wealth of information. This information can be broken down by resource category, branch of service, military mission, and weapon system.

Direct Costing estimates for any given year are not independently estimated from previous years. For many systems yearly additions are added to the prior year's stock to determine the current stock estimate. Any misestimate leads to a perpetual error, i.e., the estimates are biased. Systematic biases in direct observation or aggregation will result in ever increasing errors in final estimates of Soviet defense expenditures.

Thus, for Direct Costing to maintain a given level of accuracy, alternative methods must exist to identify the direction and magnitude of cumulative biases. Existing alternative methods provide estimates of the ruble value of Soviet defense spending. These estimates do not rely on the Direct Costing data base. However, they too are subject to biases. But, since they are based on different data, they can provide a useful check and balance to Direct Costing.

Alternative estimation methodologies provide additional information on Soviet perceptions and tradeoff decisions. Tradeoffs between defense and other state spending are implied when using budget derived estimates. Similarly, economic growth derived estimates imply tradeoffs

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between growth of defense and non-defense spending. The Direct Costing methodology came dramatically to the forefront in 1975. An independent source provided convincing information that the then current estimate of total Soviet defense spending, in a ruble numeraire, for 1970 was in error by nearly 100 percent. This finding contributed to the formation of a panel of experts, called Team B, to analyze why past intelligence assessments failed to alert the national leadership to important Soviet military developments. Their highly critical report echoed the call for a new approach to the analysis of Soviet defense expenditures.

Purpose of the Study

This study examines the environment of the current estimation methodologies and their implications to the decision making process. The work was undertaken in response to a request from the Office of the Secretary of Defense/Net Assessment to examine the estimation problem in a new and speculative manner. This objective included both the objective estimates of Soviet defense spending and the policy issues involved when comparing this expenditure with that of the U.S.

Outline of the Study

The first stage of the study reviews existing methodologies. This provides a point of departure for the alternative methodology and a basis for comparison. Of particular emphasis are the implications of these methodologies for policy making. The Direct Costing approach of the CIA and the Residual Estimation technique of Mr. William T. Lee receive special emphasis.

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The next stage develops the theoretical basis for the alternative estimates. These aggregate estimates provide an indication of the direction and magnitude of the cummulative biases in the current, more detailed methodologies. The alternative estimation model evolves from the concept of the burden of defense expenditures on an economy. This concept is developed in the contest of a multi-equational, structural model. The model establishes a single period, general equilibrium framework that combines the supply of factor services with the aggregate demand for goods and services.

Because of the model's complexity, no attempt is made to calculate the values of its parameters. Instead, simplified correlative forms suggested by the burden model are constructed and exercised.

The final stage of the study analyzes the problems involved in comparing U.S. and Soviet defense spending. The Direct Costing approach provides a dollar cost estimate for the U.S. to replicate the Soviet arsennal and to operate that arsennal as the Soviets do. The present technique directly compares this estimate with the level of U.S. defense spending.

Alternative forms of comparison are proposed. The most general forms rely on utility theory and suggest that utility may be a useful proxy for perceived capability. Several alternative forms of the index relationship are proposed that provide second order approximations to the unknown, underlying utility function. These alternative forms are tested against a subset of real data involving Soviet ships. A variation of the revealed preference technique is used to calculate the parameters of a utility function compatible with the given data. The

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alternative index relationships are further tested against several sets
of hypothetical data representing different relative levels of U.S. and
Soviet defense spending.

A secondary method of comparison, involving production function
relationships, is also developed. Comparisons based on these production-theoretic indices can provide useful information concerning the
resource implications of defense spending.

Additional information on U.S. joint defense planning is
included in Appendix A, budgetary review organizations in Appendix B,
the Soviet defense budget process in Appendix C, Soviet statistics
in Appendix D, the Soviet State budget in Appendix E, and economic
aspects of the Soviet economy in Appendix F.

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CHAPTER II

THE UNCONVENTIONAL APPROACH

This chapter summarizes the budgetary approach to estimating Soviet defense expenditures developed by William T. Lee. After presenting an overview of the Lee methodology, the specifics of the three major components of the approach as well as various comments and criticisms that have been made by other Sovietologists concerning specific aspects of the methodology are presented.

Overview

The "Unconventional Approach" derives its aggregate estimate for Soviet National Security Expenditures (NSE) as the sum of three components: (1) national security durables; (2) personnel pay and maintenance, operations and maintenance of the Ministry of Defense (MOD), and military construction; and (3) military research, development, test, and evaluation (RDT&E).

National security durables are somewhat analgous to the U.S. definition of procurement and "...include procurement, prototypes for military and nuclear weapons R&D programs, space hardware, and probably some spare parts produced to support the USSR civil and military space programs." (Lee, 1977, p. 33) The second category of operations and maintenance costs includes:

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...(a) personnel costs (pay and wages of uniformed and civilian personnel; food, clothing, and medical supplies and services); (b) operating costs (all fuel, power, chemicals, spare parts, and water; materials and services required for current operation and maintenance of the MOD establishment, other than personnel costs); (c) capital repair of facilities and equipment; (d) military construction; and (e) official travel.

Military RDT&E includes all applied research, development, prototype testing, and evaluation, including all facility operations and maintenance costs, for and by the MOD in the course of weapons systems acquisition. Space includes all similar costs performed in order to carry out national space programs, civil and military. In both cases, unsuccessful as well as successful programs and projects are included in the information. (Lee, 1977, p. 36)

National Security Durables

Published Soviet statistics comprise the major portion of Lee's data base. His belief in the general accuracy of these statistics is supported by Nove's research, which shows that published Soviet data, although sometimes difficult to define, are either identical to or are excerpted from the very same data that Soviet officials use for planning and decision-making. (Nove, 1974) Such data are the key in Lee's derivation of national security (NS) durables.

Lee calculates the National Security durables as a residual of the Machine Building and Metal Working (M&MW) sector of Soviet industry. The gross value of output (GVO) of the M&MW sector is taken from either the USSR Central Statistical Directorate (TSU) or the USSR State Planning Commission (Gosplan). To derive the GVO of the machine building (MB) the GVO of metal working and repair is subtracted from the GVO of the M&MW sector. From this figure, the value of intermediate products is subtracted to determine the final demand (FD) for machine

building. Net exports are then subtracted in order to obtain the domestic final demand of machine building. Finally, producer and consumer durables (net of imports) are subtracted from domestic final demand to obtain the value of NS durables as a residual. In summary form:

1. M&MW GVO - MW and repair = MB GVO

2. MB GVO - intermediate products = MB FD

3. MB FD - exports + imports - producer and consumer durables = NS durables. (Lee, 1977, p. 37)

There are three published sources for M&MW GVO from Soviet sources. The first, Gosplan data, are generally less comprehensive since a higher level of accuracy is felt to add little to the planning decisions. From Soviet sources, Lee (1977, p. 39) states that, (Gosplan M&MW GVO) "does not include the GVO of subsidiary industrial enterprises; repair of equipment in construction, transport, and trade organization; industrial enterprises owned by collective farms and by consumers cooperatives; or prototypes that are not 'sold to the outside'." In 1972, Gosplan published a detailed projection of M&MW GVO for the years 1970-1975 which appeared to be projections from an input-output (IO) model.

The TSU ministerial M&MW GVO series is called the "establishment" series and is believed to exclude M&MW products produced in other than M&MW sector industries but to include non-M&MW which are produced in M&MW industries. The ruble prices reported in the TSU handbooks are expressed in producers' prices (factory cost + permitted rate of profit). (Lee, 1977)

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M&MW GVO derived from published IO tables are referred to as the commodity series and is believed to exclude the non-M&MW products produced in M&MW enterprises and to include M&MW products produced by other sectors of the economy. (Lee, 1977) IO tables are expressed in purchasers' prices (producers' prices + turnover tax (where applicable), transportation, and distribution costs). (Lee, 1977) Translation of the published Soviet IO tables and their reconstruction into producers' prices has been performed by Treml and his associates. (Treml, Kostinsky and Gallik, 1973; Treml, Gallik, Kostinsky, Kurtzweg and Tretyakova, 1976) Unfortunately, these tables do not include the rows and columns that refer solely to military output. The IO tables do provide information that can be used to identify the flow of intermediate products. This identification is necessary to derive final demand and to separate MW and repair from M&MW when constructing separate series for MB. (Lee, 1977) According to Lee (1977, p. 42), final demand from the IO tables "can be distributed only by 'public consumption', 'private consumption', and 'other FD'."

Lee derives the GVO of MW and repair from the IO tables. Official indices are used to extrapolate these data for the years in which IO tables are not published. However, according to Lee (1977), a former Soviet economist claims that the MOD is not included in either the MW or the repair categories of the IO tables. It should also be noted that since these prices are derived from IO tables, they are producers' prices. Likewise, the IO tables are used by Lee in calculating the value of intermediate products in order to arrive at final demand for machine building.

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Imports and exports (excluding military equipment) of durables are regularly reported by the Soviets in foreign trade prices. However, there is some uncertainty concerning the conversion factor between foreign trade rubles and domestic price rubles. Also, this conversion factor may vary between imports and exports, although Treml's study indicates that these values are the same in the 1966 IO tables. (Lee, 1977)

For producer durables, Lee uses Soviet publications that list standard accounting (estimate) prices. These estimate prices are used for planning purposes and consist of five elements: (1) the estimating norms for construction work; (2) wholesale prices and tariffs; (3) labor norms and wage rates; (4) amortization deduction norms; and (5) norms for overhead expenses, planned profits, and charges of sales-supply organizations. (Lee, 1977) These figures are included in the TSU handbooks, and must be transformed to agree with price categories used for M&MW data. Among the discrepancies are,

> ...First, the durables are reported include imported
> durables values in domestic "estimate" prices. Second,
> ... the producer durables in the *N.Kh.* handbooks do
> not include acquisition of machinery and equipment
> by hospitals, schools, nurseries, and some other un-
> installed equipment at construction sites is not
> included in the producer durables component of capital
> investment. (Lee, 1977, p. 192)

Some data on consumer durables were published (retail prices) in the 1964 TSU handbook. The CIA has also developed estimates of the value of consumer durables based on product samples taken in 1955, adjusted for the probable value of consumer items not included in the sample. (Lee, 1977) Consumer durables can also be extrapolated from

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data in the published IO tables. The data in "commodity" prices can be obtained by using conversion ratios calculated by comparing TSU series with the IO tables.

The main criticism of the technique of using M&MW residuals to estimate the value of NS durables centers on possible systematic biases in the basic data or in the indices used to extrapolate the data. Double counting (e.g., the inclusion of intermediate products in the final demand figure) may bias the data, although the magnitude of this effect is believed to be small by both Becker and Cohn. (Lee, 1977)

As new products are introduced, their prices are increased by a profit percentage which is higher than that of existing products. This overpricing of new products may also introduce a systematic bias in the published Soviet data on M&MW GVO. The existence or the magnitude of this bias has not been agreed upon among Sovietologists.

Potential biases may be introduced when comparing series produced by different Soviet agencies and when translating the data both into producers' prices and current and constant prices. Although the potential for error is considerable from these effects, analysis of the sources of specific data and care in making the transformations can reduce the magnitude of the error. At the present time, the data and analytic techniques have not been sufficient to resolve these questions.

Personnel Pay and Maintenance

In calculating personnel pay and maintenance costs, Lee uses a method developed by Cohn and Becker. In this method the number of

military personnel and the average cost for pay and maintenance are estimated separately. (Cohn, 1970) Additional research on these cost factors has been performed independently by Brubaker (1973).

For estimating the level of military personnel, Lee modifies statements made by Krushchev in the 1950s that give specific numbers. These numbers are adjusted upward to account for increases in strategic forces and for the expanded military presence along the Chinese border. Personnel in tactical forces are thought to remain at their earlier levels. (Lee, 1977) The resulting estimates generally agree with the CIA estimated manpower level of nearly four million men in 1965 and nearly five million in 1975. (U.S. CIA, 1976)

The costs of personnel pay and maintenance were refined by Becker using the expected saving figures given by Khrushchev when he announced troop cuts in 1960. Lee follows Cohn's recommendation to use the Soviet average wage index to account for probable increases in personnel pay. The relative wage rate has been maintained at a lower level due to the large number of conscripts. However, as a result of the increasing technical requirements that accompanied the introduction of sophisticated weaponry, the average wage rate still increased significantly through the 1960-1970s. (Brubaker, 1973) A two percent per annum increase in pay was added by Lee to account for the general increase in the standard of living. (Lee, 1977)

Operations and Maintenance of the MOD

For the operations and maintenance category of Soviet defense
costs, Lee gives the following rationale for his estimation methodology:

> No evidence has been found in the public domain
> that directly relates to the cost of operating and
> maintaining the MOD establishment, or of construct-
> ing and equiping MOD facilities, such as barracks,
> airfields, repair plants, communications facilities,
> and the like. On the other hand, the "Defense"
> budget appears to include little or no procurement
> in most years since 1955. Hence, "Defense" less
> estimated personnel pay and maintenance is used as
> the best, albeit imperfect, approximation of the
> cost of operating and maintaining the MOD establish-
> ment and of military construction that can be
> derived from the information available in the public
> domain. (Lee, 1977, p. 37)

Lee contends that use of U.S. analogue factors are probably not
applicable due to the differences in labor factor costs and operating
procedures for military equipment. However, Lee recognizes that
significant distortions may be introduced if "Defense" less personnel
costs are blindly used as the surrogate for operations and maintenance
costs. Since 1970 the published "Defense" item has remained constant
or declined slightly, despite increased construction activity and the
introduction of more expensive to maintain, sophisticated military
hardware. To account for this underestimation, Lee estimates non-
personnel operating expenditures as 148 percent of personnel expendi-
tures for the years 1971-1975. This represents the average amount by
which the former exceeded the latter from 1968 through 1970. (Lee,
1977) Published statements from a number of Soviet officials are used
by Lee to support his contention that the published "Defense" budget

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includes only operations and maintenance and military construction costs, although apparently some of these costs are "hidden" under other categories in the Soviet budget. Unexplained "residuals" and the "Financing the National Economy (FNE)" item are possible sources for additional defense costs.

Research, Development, Test and Evaluation (RDT&E)

According to Lee:

> The best surrogate for total Soviet RDT&E and space outlays that can be constructed at this time appears to be the sum of the following elements: (a) wage bill of the RDT&E labor force; (b) material inputs to RDT&E institutions; (c) capital outlays for the construction and equipping of RDT&E plants; and (d) the cost of RDT&E performed in the VUZ_y (higher education institutions). This procedure will fall short of total outlays by the cost of the following activities: (a) RDT&E performed by series-production factories, geological-survey organization, and facility-design institutes serving construction; (b) pay and maintenance of uniformed MOD personnel engaged in RDT&E; and (c) probably, operating costs of weapons-system test and evaluation performed at MOD proving gounds, flight-test ranges, and other facilities. (Lee, 1977, p. 38)

In summarizing the status and accuracy of the above categories, Lee states that:

(1) The estimate of the employment in RDT&E activities may be underestimated since it is possible that uniformed and MOD civilian personnel are not included.

(2) The wage data are reliable.

(3) Investment in R&D plant is accurate for those items specifically identified, but certain investment facilities may be excluded.

(4) Material inputs to RDT&E are inadequately specified and, the entry in the national income accounts for the "material expenditures in scientific institutions and administration" that are used as a surrogate.

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(5) The military portion of the published "Science"
    item in the Soviet budget is roughly taken as
    25%, based on a statement made by Trapezhnikov.
    According to Lee, this figure excludes civil
    space expenditures. (Lee, 1977, pp. 50-51)

This methodology for estimating RDT&E espenditures differs from
that of the CIA and Rand (based on a study by Nimitz), which assumes
that the "Science" item in the Soviet budget includes total RDT&E costs
and that the military portion is in the range of 2/3 - 3/4 of the total.
This methodology also differs from the assumptions made by Cohn, who
calculates a range by using both 50 percent and 100 percent of the
"Science" estimate in aggregating defense costs. (Cohn, 1973)

Advantages and Disadvantages of the
Unconventional Approach

In summary, Lee states that the advantages of his method, which
is based upon Soviet industrial production, budgetary, labor force, and
national income data, are as follows:

1. It is derived directly from the Soviet data - in
   rubles.

2. It is not subject to the index number effect of
   applying U.S. prices to Soviet weapons and
   technology.

3. It is not dependent on estimated ruble/dollar
   ratios.

4. It reveals resource allocations - between invest-
   ment, consumption, and defense - in each Soviet
   annual and Five Year Plan.

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5. It is one plausible alternative to the direct-costing method and provides an aggregative check on the results of that approach.

6. It provides an approximate picture of USSR NSE as Soviet leaders see it. (Lee, 1977, p. 52)

Lee further lists the following as being the major disadvantages of his "unconventional approach":

1. Despite the steady improvement in the data over the years, there are a number of areas in which more precise and internally consistent data would narrow the range of uncertainty.

2. The trend is more reliable than the magnitudes for which the range of uncertainty probably cannot be reduced below $\pm$ 10 percent.

3. The R&D and space estimates are particularly rough. Further research and better data are needed.

4. The unconventional method cannot distribute estimates of total NSE by branch of service or by major mission. (Lee, 1977, p. 52)

The most important element of the disadvantages is that the resulting estimates do not contain error bounds. Indeed, the construction of the estimates is not compatible with such bounding. One can reasonably assume that the estimates are biased to an unknown degree. However, such biases should be relatively uncorrelated with those resulting from the CIA's Direct Costing technique, a highly useful property. The other advantages are similarly valuable.

Other Existing Estimation Methodologies

This section summarizes the main methodologies presently used for estimating Soviet defense expenditures, besides the Direct Costing approach of the CIA and the Unconventional Approach developed by William T. Lee. The emphasis here will be on the data bases employed and how they are different from the CIA and Lee approaches.

Stanley Cohn-SRI Approach

The Stanford Research Institute (SRI) and Soviet scholar, Stanley Cohn, have assumed that the "Defense" budget item covers all Soviet MOD expenditures except for RDT&E, which is financed from the "Science" budget item. Cohn (1973, p. 148) quotes an "official source" who claims that:

> ...the allocation in the state budget to the Ministry of Defense includes payments for delivery of armaments, supplies, equipment, fuel, food, and other material supplies. It also covers personnel pay military, construction, armament equipment repair, and operations of military hospitals, schools, and clubs. Conspicuously omitted are outlays for research and development and for nuclear research and procurement.

Cohn, like Lee, believes that the costs for industrial enterprises that produce military hardware are financed from the "Financing the National Economy" and from the profits generated from these enterprises. Cohn accepts the Nimitz's research (from Rand), which assigns a percentage (either 50 percent or 100 percent) of the official "Science" budget as the value of Soviet RDT&E. (Cohn, 1973)

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Cohn also acknowledges the possibility that the level of total
military outlays exceeds that derived from the two categories of
"Defense" and "Science". These additional expenditures, he believes,
might also be included in certain budget residuals in the Soviet
budget. Cohn also states, however, that non-military costs are in-
cluded in these same residuals and that this trend is unsystematic and
quantifiable only as a range. (Cohn, 1973) Due to these uncertainties,
Cohn does not include these additional cost elements in his estimate.

Cohn's methodology assumes that an independent estimate can be
made for the personnel costs portion of Soviet defense expenditures,
which can then be subtracted from the total. The remainder can be
divided between the procurement of military equipment and hardware and
the operations and maintenance of military force. Again, expenditures
for RDT&E are represented entirely as a portion of the "Science"
budget. (Cohn, 1973)

Cohn's explicit calculations of Soviet defense costs are
stated in terms of alternative time series, and each cost estimate
varies with respect to what portion of the "Science" item has been
attributed to the military, the composition of the non-personnel por-
tion of total "Defense", and the deflator rates that adjust expendi-
tures.

Cohn and Lee agree that because of the ambiguities in the
published Soviet IO matrices, it is not feasible to reconstruct the
pattern of Soviet resource use for defense based on these tables.
(Cohn, 1973)

Composite Estimation Methodologies

In addition to the previous methodologies, which are designed to provide somewhat unique and complete estimates of Soviet defense expenditures (albeit at different levels of aggregation), other Soviet scholars have examined either specific aspects of the problem or the relationships between the previously discussed techniques.

Block, in examining Soviet publications, states that, "atomic energy production, strategic and military stockpiling, the civil defense organization, some military training, and, at least partly and at times, the paramilitary police and foreign military aid..." have been financed from the "Financing the National Economy" and budget residuals. (Block, 1973, p. 180) Block further states that the composition of the "Science" item in the Soviet state budget can be derived from statistical handblloks published months or years after the release of the budget figures. Additional sources of "Science" funds are located in the "Social-Cultural Measures" and in organizational and enterprise funds (profits) according to Block. These funds are in addition to those published in the "Defense" budget. (Block, 1973)

The breakdown of the "Science" item, which is eventually published by the Soviets, is for that portion spent by "Federal authorities, i.e., in the USSR, the All-Union budget, with the rest allocated to the USSR's constituent units, the Republics." (Block, 1973, p. 181) He assumes that any portion of the "Science" item that includes defense related expenditures is financed from the All-Union portion (90.8 percent of the total in 1970). Block relies on data, supplied by Soviet

Finance Minister Garbuzov, that indicates that "Science" was net of investment until the plan figure for 1970, and includes investment for the years after 1970. He points out that if the direct charges for defense-related equipment include the use and depreciation of capital goods and facilities, then "Science" must be adjusted to avoid double counting. In his analysis, Block does not attempt to divide the "Science" budget between defense and non-defense related expenditures, which would be necessary when aggregating defense-related expenditures.

In estimating the number of military personnel, Block (1973), includes the results of the London Institute for Strategic Studies (ISS), which also provide some breakdown for paramilitary forces.

Campbell, Earle, Levine, and Dresch (1973), have studied some of the methodological problems which arise when comparing the Soviet and U.S. economies. Their analysis includes much of the earlier work by Cohn and Lee as well as the U.S. Arms Control and Disarmament Agency (ACDA). For economic aggregate data, which are the key data sources for budgetary approaches, Campbell (1973, p. 127) lists the following methodological problems:

(1) Limited information is available concerning the derivation of the data or details of its composition.

(2) The Soviets employ a variety of pricing systems which complicates data interpretation.

(3) Soviet indices used for calculating components of economic aggregates do not appear consistent with certain known price movements.

(4) The Soviets do not publish any ruble prices for
military and space hardware.

Campbell (1973, p. 128) also lists the following major uncer-

tainties in estimating Soviet NSE using the SRI-Lee approaches.

(1) The possibility that the residual, which is inter-
preted as NSE durables, obtained from the disaggregation
of the GVO of M&MW, contains other (unknown) components;
(2) the possibility that certain durables for national
security may have been included elsewhere; (3) limita-
tions in the procedures used to obtain the remaining
three major components of NSE - their sum constitutes
approximately one-third of the total NSE; and (4) conver-
sion of data from one type of price basis to another by
the use of questionable Soviet indexes.

Campbell (1973, p. 128) proposes the following procedure for deriving

the nondurable component of Soviet NSE using the SRI approach:

The estimate of military personnel pay is based on
the estimated 1958 average military pay rate (Source:
N. Nimitz) and on the Soviet index for average wages
of workers and employees. Military personnel main-
tenance cost is based on the stimated 1958 average
military maintenance rate (Source: N. Nimitz) and on
the average of Soviet wholesale price indexes for the
Light and Food industries. Based on U.S. experience,
operations and maintenance costs are stimated at 10
percent of the sum of the reconstructed durables and
military personnel outlays. Capital investment in
military facilities and military $&D plant was esti-
mated by doubling the value of capital investment in
R&D plant, which itself is derived from two budget
entries, Science and Financing the National Economy
(FNE).

Campbell (1973, p. 129) considers two methods for estimating the

RDT&E outlays by the Soviet Union. "The 'output method' sums the

following estimated components: cost of prototype hardware, cost of

R&D performed in academies and institutions of higher education, and R&D

capital outlays including capital repair." He further states that:

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The key assumptions underlying this method are: (1)
the GVO of the M&MW sector includes almost all of
the cost of prototype production; (2) the estimate
of the prototype fabrication cost is the difference
between the GVO of the M&MW sector and an estimate
derived by summing the costs of M&MW factor pro-
duction; and (3) the reported M&MW employment does
not include the research personnel. (Campbell,
1973, p. 129)

For the "input method" Cambell states:

The 'input method' sums the estimated R&D outlays
for wages and social insurance, personnel support
and administration, materials, and capital outlays,
including capital repair. The main assumption of
this method is that there is no significant overlap
between the calculated wage bill of the RDT&E
personnel and the estimate of materials. (Campbell,
1973, p. 129)

Campbell (1973) lists four factors that act to change the ruble/

dollar conversion rations over time:

(1) Different inflation rates in the two countries.

(2) Changes in individual ruble/dollar relatives.

(3) Changes in the U.S. and Soviet product mix.

(4) Introduction of new products.

As far as Soviet price indices are concerned, Campbell's main reserva-

tions concern the methods used in their computation and that the

coverage of the samples is limited.

Finally, Campbell recognizes that there are large areas of

economic activity for which no adequate measures of prices or outputs

exist. In these cases, the cost of inputs to these activities is used

as a surrogate of the unknown output. The validity of this technique

presumes that Soviet decision-makers estimate that the value of output

is worth the resource costs. However, even with this assumption, when

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the two economies are compared, the production function must be assumed to be the same. (Cambell, 1973)

Alternative Estimates and Methodologies

In a corollary study entitled, *Development of a Baseline for the Definition and Analysis of Techniques for Estimating the Allocation of Resources in a National Economy,* the G. E. TEMPO Center for Advanced Studies summarizes the major alternative estimation methodologies. (McMeekin, Note 1) Table 1 juxtaposes the numerical results of the six basic approaches, which are:

(1) Official Soviet Defense Budget (Soviet estimates).

(2) National Expenditure Method (French estimates).

(3) External Information Method (Chinese estimates).

(4) Residual Costing Technique (lee estimates).

(5) Direct Costing Technique (CIA estimates).

(6) Revised Budgetary Technique (Cohn estimates).

The Official Soviet Defense Budget estimate is derived by adding two-thirds of the "sceintific research" portion of Title 2 of the published Soviet budget (Sociocultural Measures and Scientific Research) to the Title 3 entry (Defense). This method explicitly assumes that the published Soviet defense budget includes all procurement, military pay, operations, and maintenance expenditures. Research, Development, Test, and Evaluation (RDT&E) is assumed to be financed entirely out of the published Science budget as a constant percentage. The reader will realize that this method is basically the Cohn-SRI methodology in which one half or the entire line item for "scientific research" is added to

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TABLE 1

REVISED BASELINE ESTIMATES OF SOVIET DEFENSE EXPENDITURES FROM 1960 TO 1975
(in Billions of Current Rubles)

Year	1 Official Soviet Defense Budget	2 National Expenditure Method (French Estimates)	3 External Information Method (Chinese Estimates)	4 Residual Estimation Technique (Bill Lee's Estimates)	5 Direct Costing Technique (CIA Estimates)	6 Revised Budgetary Technique (Stanley Cohn's Estimates)
1960	9.3	21.6	(18.7)	16.0	22.6	17.3
1961	11.6	22.6	20.4	18.5	24.1	20.3
1962	12.6	23.6	22.2	21.0	25.7	22.3
1963	13.9	24.7	24.2	23.0	27.3	23.4
1964	13.3	25.9	26.4	24.5	29.1	24.5
1965	12.8	27.1	28.8	26.0	31.0	29.6
1966	13.4	28.3	32.0	28.0	33.0	28.3
1967	14.5	29.6	35.5	32.5	35.2	26.8
1968	16.7	31.0	39.5	38.5	37.5	33.4
1969	17.7	32.4	43.8	42.0	39.9	37.1

TABLE 1 - continued

Year	1 Official Soviet Defense Budget	2 National Expenditure Method (French Estimates)	3 External Information Method (Chinese Estimates)	4 Residual Estimation Technique (Bill Lee's Estimates)	5 Direct Costing Technique (CIA Estimates)	6 Revised Budgetary Technique (Stanley Cohn' Estimates)
1970	17.9	33.9	(48.7)	46.0	42.5	35.4
1971	17.9	35.4	53.0	50.0	45.3	38.6
1972	17.9	37.0	57.6	54.5	48.2	35.5
1973	17.9	39.7	62.6	60.5	51.4	38.9
1974	17.7	40.6	(68.2)	65.0	54.7	39.9
1975	17.4	42.3	(72.6)	71.5	58.2	41.8
Average Rate of Growth 1960-1969	6.7%	4.6%	10.0%	11.0%	6.5%	7.9%
Average Rate of Growth 1970-1975	0.0%	4.6%	8.2%	9.0%	6.5%	2.8%
Average Rate of Growth 1960-1975	4.3%	4.6%	9.5%	10.5%	6.5%	6.0%
1960 NSE Estimated Share of the Soviet GNP 227 rubles)	.041	.095	.082	.070	.099	.076

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the published defense budget figure.

The direct costing and residual costing techniques are covered in considerable detail in other sections, and will not be further discussed in this section.

The National Expenditure Method was developed by French Sovietologists using Soviet national accounting data. Investment spending devoted to armaments are derived using the following residual technique:

Armament expenditures are presumably listed as net capital formation (accumulation) in the Soviet national accounts. Then, "... that part of capital formation used for military purposed can be isolated by a sequence of calculations."

Military RDT&E expenditures are approximated by applying the two-thirds factor to Scientific Research in the published budget. Personnel costs are approximated by using estimated Soviet manpower levels and appropriate pay scales. Operations and maintenance costs are assumed to be 42 percent of personnel costs.

The External Information Method relies on some sketchy figures reported in the *Peking Review* on January 20, 1975. In this report, defense expenditures were estimated as a reported share of Soviet national income. Table 2 below summarizes this information:

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TABLE 2

EXTERNAL INFORMATION METHOD ESTIMATES

Year	Reported Share of Soviet National Income (Percent)	Soviet National Income (Billions of Rubles, Current Prices)	Defense Expenditures (Billions of Rubles, Current Prices)
1960	13.1	142.8 - 145.0	18.7 - 19.0
1970	17.1	285.5 - 289.9	48.8 - 49.6
1974	19.6	348.2 - 353.7	68.2 - 69.3
1975	20	362	72.4

CHAPTER III

THE DIRECT COSTING APPROACH

By far the most sophisticated and detailed methodology for estimating Soviet defense expenditures is the CIA's Direct Costing or "building block" approach. This chapter examines the major unclassified aspects of this methodology and their relative strengths and weaknesses in some detail. The discussion of direct costing will conclude with a summary of the similarities and differences between this approach and the various budgetary approaches.

Overview

Direct costing was developed by the CIA in the early 1960s because of perceived inadequacies in the published Soviet defense budget. Political considerations and other unknown factors appeared to affect both the composition of the published defense budget and its consistency over time. Direct costing was designed to be an independent approach to estimating total Soviet defense spending. This initial effort has been expanded far beyond what had been originally envisioned. An elaborate computer based model--the Strategic Cost Analysis Model (SCAM)--now performs the analytic tasks necessary for developing the estimates and simulating the effects of different assumptions and input parameters on the estimated cost stream.

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Direct Costing begins with a physical identification of specific items of military hardware, support equipment, and personnel. The physical quantities are then multiplied by their individual prices and aggregated to obtain an estimate of the cost of Soviet equipment. The costs of personnel pay and maintenance and research and development (R&D) are then added to the above-mentioned costs. The total cost may then be divided into categories such as service component, military missions, and specific program. The estimates are made in a dollar numeraire to compare with U.S. expenditures and in a ruble numeraire to provide a Soviet perspective. This procedure will now be discussed in considerably more detail.

Dollar versus Ruble Estimates

The objective of the CIA's dollar based estimate is to

> ...estimate how much it would cost to produce and man
> in the U.S. a military force of the same size and with
> the same inventory of weapons as that of the Soviets,
> and to operate that force as the Soviets do.

> Such an approach can provide a general appreciation
> of the overall magnitude of the defense activities in
> the two countries. Dollar cost data also provide a means
> for aggregating dissimilar elements of each country's
> military programs into comparable categories and thus
> can show trends and relationships between the two
> defense establishments that are difficult to discern
> in other ways. (U.S. CIA, 1976, p. 1)

Dollar based comparisons between U.S. and Soviet defense spending do not, and cannot, provide a precise numerical juxtaposition of the two levels of defense spending. The theoretical rationale for this falls under the general category of the "index number problem." Using

a dollar numeraire for the level of Soviet defense spending does allow one to address the question of how large would U.S. defense spending have to be if the U.S. were to man and to operate the Soviet arsenal.

Although this concept appears simple, its application is fraught with formidable problems. The CIA states that the objective of the dollar costing approach is to, "...estimate how much it would cost to produce and man in the U.S. a military force of the same size and with the same inventory of weapons as that of the Soviets, and to operate the force as the Soviets do." (U.S. CIA, 1976, p. 1) This statement explicitly mixes U.S. and Soviet military philosophies in developing the dollar estimate.

Military hardware and personnel costs are calculated by strictly applying U.S. production technology and techniques; U.S. cost accounting procedures and profit rates; U.S. pay scales and personnel support costs; U.S. maintenance, repair and inventory procedures; and (at least implicitly) U.S. technology and facilities for conducting R&D. It is widely acknowledged that the categories often differ considerably between the U.S. and the Soviet Union. Systematic differences show up as the "index number problem." However, this U.S. philosophical orientation is "disturbed" by the condition that cost of the military force is calculated using Soviet, not U.S., operating procedures.

This last condition is incompatible with the stated purpose of providing a consistent means of comparing U.S. and Soviet defense activities. Additionally, since we presumably know our operating philosophy better than we do that of the Soviets, using Soviet procedures is inherently less accurate than using U.S. procedures.

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Since the United States does not have direct access to the specific ruble costs of Soviet weaponry, most Soviet defense costs are calculated in a dollar numeraire and translated into rubles using ruble/dollar conversion ratios. These dollar costs then do not suffer from errors in the translation from ruble prices.

Three primary methods are used to develop the estimated dollar costs. First, if an actual item of Soviet equipment or a complete set of specifications or performance parameters are available, the information is furnished to a U.S. company with experience in similar systems. The company then estimates what it would cost to produce some specified quantity. A potential problem with this method is the inability of defense contractors to accurately estimate costs for U.S. systems--one cause of the overruns they have experienced. The CIA has attempted to minimize this error source by concentrating on the actual cost at completion of similar systems when developing the cost estimates for Soviet equipment.

A second method used for calculating dollar cost estimates involves the use of cost estimating relationships (CERs). Direct cost estimation is theoretically more accurate, but it is significantly more expensive than other methods and it requires more information on Soviet weapons than may actually be available. CERs offer a compromise, which, if correctly constructed, does not have a systematic tendency toward either understimation or overestimation. The CERs concentrate on the important characteristics of a weapons systems. For example, the cost of a missile, less its warhead and guidance, may be directly related to its weight, range, and type of propellent. If the

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relationship between these variables and cost can be developed, then the relationship can be used to estimate the cost of a new missile with different characteristics or performance parameters. Obviously, the accuracy of this method depends largely on the ability to identify the important cost-related variables and the structure of the relationship. Even if this relationship is captured, such a model may need continual updating both to include new missile systems as they are introduced and to eliminate from the model systems those that are not compatible with the new characteristics. CERs are an important aspect of the SCAM model.

The final, and least accurate, method for developing dollar cost estimates for Soviet weapons systems involves the use of U.S. analogues. If insufficient information exists for direct cost estimates and reasonably accurate CERs are not available, the item is assigned the cost of the most comparable U.S. system. Generally, items calculated in this manner are relatively low cost (e.g., ammunition, clothing, etc.) and any resulting error has less of an impact on the overall estimate of the dollar cost of Soviet defense expenditures.

But, as Lee (1977, p. 5) points out,

Dollar estimates arenot very useful in assessing
Soviet objectives, national priorities, the Soviet
leaders' perception of the political utility of
military power, and the strength and weaknesses in
Soviet bargaining positions ...because the Soviets
make their decisions, allocate their resources,
and keep their accounts in rubles.

The CIA (1976, p. 2) recognized these limitations and recommends tempering any conclusions because the dollar cost estimates,

(1) Cannot be used alone to draw inferences about the relative military effectiveness or capabilities of U.S. and Soviet forces. Other data, such as the size and technical characteristics of the forces, the geographical locations of the two countries, their allies' capabilities and requirements, strategic doctrine and tactical concepts, morale, command and control capabilities, and other information must also be considered.

(2) Do not measure actual Soviet defense expenditures or their burden on the Soviet economy. These questions are addressed by different analytical techniques yielding estimates of the ruble costs of Soviet military programs.

(3) Do not reflect the Soviet view of the distribution of the USSR's defense effort. The price structures in the two countries are substantially different. Additionally, neither the system of accounts nor the structuring of expenditures by military mission is the same for the Soviet Ministry of Defense and the U.S. Department of Defense.

The CIA's ruble estimates of Soviet defense expenditures are meant to correct some of these deficiencies with the dollar-based estimates.

Calculating Soviet defense expenditures in dollar terms has been labeled the "threat assessment", while the estimate in a ruble base is termed the "burden assessment." One major use for the ruble estimate is in calculating the ruble ratio of Soviet defense spending and GNP — a measure of the burden of defense. (*Business Week*, 1977)

Ruble estimates of Soviet military equipment are, in most cases, derived from the dollar estimates by applying a ruble/dollar conversion ratio. These ratios are separately calculated for a number of categories of systems, subsystems, or components based on comparable pieces of equipment for which relative U.S. and Soviet prices are available.

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These conversion ratios are subject to some uncertainty as to their applicability to specific items of military hardware and their constancy over time. Lee (1977) considers them to be the weakest link in the procurement estimation equation. Campbell (1973) lists four factors that tend to change the ruble/dollar conversion ratios over time. These are (1) different inflation rates in the two countries; (2) changes in individual ruble/dollar price relatives; (3) changes in the U.S. and Soviet product mix; and (4) the introduction of new products. Campbell concludes that changes in the product mix, especially the introduction of technically advanced products, are the dominant factors in increasing the ruble/dollar ratio for national security expenditures in the period 1955-1970.

As in the case for the cost estimating relationships, the calculation of ruble/dollar conversion ratios is strongly influenced by the data base employed in deriving the initial ratios and the methods used to adjust them for technical and temporal changes.

Included Activities

The primary use for dollar cost estimates of Soviet defense activity is for comparison with U.S. expenditures. Direct costing allows such a comparison to be made at numerous levels of aggregation. In general, the defense activities are defined to include

> ... those activities that in the U.S. would be funded
> by the Department of Defense (less foreign military
> assistance), defense nuclear programs such as those
> funded in the U.S. by the Energy Research and Develop-
> ment Agency (ERDA), and the activities of the U.S.

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Coast Guard and the Soviet militarized security forces
(border guards and internal security troops). Excluded
from this definition are space activities that in the
U.S. would be funded by NASA, civil defense (except for
the pay and allowances of uniformed personnel engaged
in such programs), and veterans' programs. (U.S. CIA,
1976, p. 1)

Soviet defense costs are accumulated into three basic cost
categories: (1) investment, (2) operations, and (3) research, develop-
ment, test, and evaluation (RDT&E). Investment includes the procure-
ment of military hardware and the construction of facilities. Opera-
tions cover the material and manpower costs associated with the opera-
tions and maintenance of the stock of military weapons and equipment.
RDT&E expenses cover all activities up to the deployment of new weapons
systems.

Related U.S. cost data is obtained from the Total Obligational
Authority (TOA) series in the Department of Defense Five Year Defense
Program.. Adjustments are made to the cost figures to more effectively
match the estimated accounting coverage of related Soviet defense costs.
(U.S. CIA, 1976)

Research, Development, Test,
and Evaluation (RDT&E)

Estimation of RDT&E costs is probably the most troublesome
aspect of existing methodologies, including Direct Costing. The out-
puts of RDT&E enterprises are rarely as observable as the production
of military hardware. Additionally, RDT&E enterprise often produce
non-defense-related research and products in conjunction with their
defense activities.

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For a number of years the CIA, following the recommendations of such noted Sovietologists as Cohn of SRI and Nimitz of Rand, applied a percentage (usually 50 percent) of the published "Science" budget entry. RDT&E, then was the only major category of direct costing which relied directly on the published Soviet budget and was not related to observables.

The RDT&E component of the direct costing estimate is now computed using a technique, although of still questionable accuracy, which explicitly considers statements of Soviet leaders and observed inputs to RDT&E enterprises.

This new estimation method follows this basic methodology:

(1) Published Soviet sources are used to derive total man-power levels and average wage rates.

(2) Soviet sources are used to calculate a ratio between wages and other costs for R&D.

(3) This ratio is applied to the labor cost estimate (based on labor inputs to RDT&E enterprises) to derive the non-labor cost.

(4) Estimated labor and non-labor costs are added together to approximate total expenditures for R&D (civilian and military).

(5) 75 percent of the published "Science" budget is subtracted from this total to remove the estimated cost of non-military RDT&E. (This follows the procedure recommended by Trapezhnikov.)

The resulting value of military RDT&E is defined to include the cost of all activities up to series production.

The basic outline of this new methodology has numerous basic similarities to that introduced by Lee.[1] Both approaches attempt to measure inputs to RDT&E enterprises, and both presume that military RDT&E comprise only 25 percent of the published "Science" budget.

There are several glaring differences in the classification taxonomy for defense goods between the CIA and Lee. The above CIA methodology includes all industrial activity up to serial production to RDT&E. Lee's definition of RDT&E is considerably more restrictive, excluding "prototypes for military and nuclear weapons R&D programs..." and presumably production activities beyond the prototype stage. (Lee, 1977, p. 33)

Despite the similiarities in methodology, the differences in estimated levels of RDT&E expenditures and the composition of those costs accentuate the problems associated with this element of defense expenditures.

The following CIA quotation (1976, p. 14) summarizes the Agency's position concerning their RDT&E estimates:

> The estimate of Soviet outlays for RDT&E is based primarily on analysis of Soviet statistics and is the least reliable of our estimates. There is considerable uncertainty about the basic data, most of which come from Soviet publications. In addition, *the esimate of the division of expenditures between the military and civilian sectors is particularly uncertain.* Despite the limitations of the specific data, what we know in general about Soviet military research programs indicates that spending for military RDT&E almost

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[1]See the chapter on the Unconventional Approach for a more detailed description of the Lee methodology.

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certainly increased between 1970 and 1975. The majority
of Soviet RDT&E funds probably were directed toward the
development of strategic systems. Moreover, the growing
complexity of modern weapons will require increasing
allocations for the development of future generations.
(emphasis by CIA)

In this age of technological sophistication, RDT&E expenditures
are key indicators of future military capability. The general lack of
verifiable information as to the level and distribution of such expendi-
tures in the Soviet Union is a major failure of existing estimation
methodologies.

CHAPTER IV

THE BURDEN OF DEFENSE EXPENDITURES

This chapter will formally develop the concept of the burden of defense expenditures on an economy. First, the different apsects of economic burden and its measurement are discussed. Next, a general equilibrium analytic framework which combines the supply of factor services with aggregate demand for goods and services is established. In the subsequent analysis the effects of factor taxes (imposed to support a particular level of defense expenditures) on output, factor employment, and returns to the factors of production are explored. The considerations necessary to maximize output and total labor income subject to a given level of government expenditures on defense are also developed.

For the analysis a model to evaluate the economic effects of defense expenditures is developed. In it is shown that the individual factor tax rates to achieve maximum output depend on the slopes of the supply curves of labor and capital, the output elasticities of production for labor and capital, and the capital-to-labor ratio.

In summary, the analysis shows that taxes reduce the wages received by labor, total labor income and the rental rate received by capital. Given the level of government spending for defense, there exists unique tax structures which maximize output or returns to the factors of production.

The above concentrates on the objective nature of the burden of
defense expenditures. But, objective measures of the tradeoffs and lost
opportunities that the country must endure to support a defense estab-
lishment may differ from the perceived burden. This subjective measure
of burden concentrates on the willingness of a country to bear what it
believes to be the strains of its defense expenditures. These sub-
jective factors have significant policy implications beyond that ob-
tained solely by objective analysis. The Soviet perception of the
burden of military expenditures is masked by its history, colored by
its ideological development, and shaped by its bureaucracy. Since the
Soviet experience is not the American experience, the subjective con-
cept of burden must be considered from the Soviet perspective, as
reflected in what they say, and much more importantly, in what they do.
The Marxist doctrine of historical determinism does not change because
different leaders follow different paths at different times. All these
factors must be considered when deriving the perceived utility of
military power. The last section of this chapter will briefly discuss
some characteristics and implications of the subjective aspect of the
burden of defense expenditures.

The Nature of Burden

In the objective analysis of burden, one is concerned with the
impact of defense expenditures on the employment and returns to the
factors of production and on the level of output.

The taxes on capital and labor required to finance defense
spending drives a "wedge" between the demand and supply functions of

capital and labor. If one takes the level of defense spending covered by government receipts, one has

$$G = \text{defense spending} = t_K \times R \times K + t_L \times W \times L \qquad (1)$$

where

K is the quantity of capital employed

L is the quantity of labor employed

R is the net of tax rental rate of capital

W is the net of tax wage rate of labor

and

t_K and t_L, the proportional taxes on capital and labor expressed as percentages of the rental rate received and the wage rate received, respectively, are given by the equations

$$R_p = R(1+t_K) \qquad (2)$$

and

$$W_p = W(1+t_L). \qquad (3)$$

The differences between rates paid and rates received by the factors represents the absolute tax rate on the respective factor. Thus, the absolute tax rate on capital

$$T^K = R_p - R \qquad (4)$$

and the absolute tax rate on labor

$$T^L = W_p - W. \qquad (5)$$

These absolute tax rates have been expressed without loss of generality as percentages of the rates received (rental and wage) in order to facilitate the solution of the model.

One measure of the burden of defense expenditures would then be the differences between the after tax wage rate and rental rate without defense and the after tax rates which include the effects of defense spending, i.e.,

$$\text{Burden (on labor wage rates)} = W_{\bar{d}} - W_d \qquad (6)$$

or

$$\text{Burden (on capital rental rates} = R_{\bar{d}} - R_d \qquad (7)$$

where

$W_{\bar{d}}$ and $R_{\bar{d}}$ are the after tax wage and rental
rates without the defense expenditures

and

W_d and R_d are the after tax wage and rental
rates with the defense expenditures.

Similarly, burden can be considered to be the net of tax total returns to labor and to capital without defense expenditures minus the respective total returns with the defense spending, i.e.,

$$\text{Burden (on labor)} = (W \times L)_{\bar{d}} - (W \times L)_d \qquad (8)$$

or

$$\text{Burden (on capital)} = (R \times K)_{\bar{d}} - (R \times K)_d. \qquad (9)$$

These two specific measures of burden concentrate on the effects of defense expenditures on the rate and the totality of returns to each factor of production. As the following analysis will show, the higher the "wedge" between what it costs to employ a unit of labor and the net receipts of labor, the lower will be the amount of labor employed.

Also, because of the lower net receipts of labor, the supply of labor will be reduced. Despite the "full employment" nature of the Soviet economy, these considerations do affect the supply and demand of the factors of production. The amount of labor imputed to the production function of an industry is in part related to that portion of the cost of the output borne by labor. Similarly, Soviet labor does have some choice between work and leisure. Leisure can take the form of time off from the job or in reduced productivity. (See Appendix F, Financial Aspects of the Soviety Economy.)

The burden borne by capital affects its potential use for the production of investment or consumer goods. Fven in the Soviet economy, a higher cost for capital will reduce the employment of capital, which lowers the potential productivity of labor. This re-duces both the demand for and the supply of capital.

An aspect of this tradeoff has been analyzed by Cohn (1973). By the use of correlation and regression analyses, he showed a signif-icant tradeoff between defense expenditures and producer durables, capital investment, and consumer durables. A lower level of correlation with public consumption was also indicated.

The economic consequences of changes in defense expenditures has been also studied by Calmfors and Rylander (1976). Using a Cobb-Douglas production function they developed monographs depicting the tradeoff between growth in defense spending and growth in consumption under varying rates of growth in capital stock, GNP, and total factor productivity. By fixing the parameters of the production function, they further developed the relationships between growth in GNP and

growth of consumption. This partial equilibrium analysis did not consider the factors which affect the supply of capital and labor or their productivities. Thus, it was a much more restrictive subset of the relationships developed in this study.

Bergendorff and Strangert (1976) have attempted to build on the Calmfors and Rylander study by considering the effects of different production functions and holding different variables constant. For example, holding defense spending and investment constant, consumption was derived as a residual. By analyzing historical growth rates in both the factors of production and in various output categories, they drew inferences as to potential growth rates in consumption, defense spending, and investment given certain policy decisions. Again, the partial equilibrium analysis did not consider the factors which affect the supply side of the relationships.

These studies consider, at least implicitly, another measure of burden -- the differences between private output without defense and private output with the defense expenditures, i.e.,

$$\text{Burden (on private output)} = O_{p\bar{d}} - O_{pd} \tag{10}$$

This gives a measure of the effects of defense spending on the output available to the private sector. A somewhat similar measure is the difference between total output (private plus government) without defense spending and total output with defense, i.e.,

$$\text{Burden (on total output)} = TO_{\bar{d}} - TO_{d} \tag{11}$$

This last measure also corresponds directly to the increase in Net

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National Product (NNP) which is foregone as a result of the expenditure for defense.

These six paradigms for measuring the burden of defense expenditures offer flexibility in adapting the specific form of the analysis to the objectives of the user. For example, the output measure can be used if the interest is on the overall amount of goods and services sacrificed to support the defense establishment. Similarly, the burden on labor may be the appropriate variant when analyzing potential internal political pressures accompanying changes in the level of expenditures.

Commonly used measures of defense burden such as the share of Gross National Product capture only first order effects on changes in total output and offer little information as to the perceptions of the defense burden. In contrast, the burden measures presented here offer a more complete picture of the economic tra.... involved in terms of the variables most likely to also affect perceptions of the burden (e.g., changes in total output and returns to labor). Furthermore, the time series of these burden variants are useful surrogates for subjective measures of the changing political perceptions of the role of military power.

While the immediate concern of this study is a comparison between the military efforts of the United States and that of the Soviet Union, the concept of burden developed here is not limited to these two countries. It can be easily extended to any two countries, any set of countries, or any block of countries (e.g., NATO or Warsaw Pact).

As an example of this extended application, one can consider that the relative contribution of our allies to our mutual defense needs

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is more accurately measured by the reductions in output and in the returns to the factors of production than by the percentages of GNP devoted to defense. Thus, these proposed measures more accurately reflect the economic consequences of defense policy decisions.

Not only do these measures provide models for analyzing the economic implications of different policy decisions, but they also provide an additional measure of the potential economic reserves of a country. Our analysis shows that a country can change its total output or the amount devoted to defense by modifying its tax policies. The extent to which these items can be increased by changing the imposition of taxes represents a reserve capability. Thus, by shifting the incidence of the taxes on capital and labor, holding total revenue (defense spending) constant, a country may be able to increase total output, or reduce some burden measure. Similarly, holding total output constant, a country can increase the level of defense spending by changing its tax policies toward a more optimum combination. Knowledge of the optimal levels at which a country is capable of performing is a necessary base for comparing relative strengths and weaknesses in supporting political or military policies.

The following sections develop a form of the relationships between the relevant economic variables and the measures of burden and the implications of these relationships. The model is based on the work of Odogwu, Canto, and Laffer (Note 3).

The Objective Development of the Concept of Burden

In this section a model to evaluate the effects of military
expenditures on the employment of the factors of production, the
returns to these factors and changes in output is developed. The
assumptions of this one period model include

1. Variable factors of supply to the market sector.

2. Marginal conditions are operative in both the production
   and factor markets.

3. The industry employs two factors of production, capital,
   K, and labor, L, in the production function.

4. The production function for output, Q, satisfies an
   unchanging (twice continuously differentiable) neo-
   classical production function with constant returns
   to scale, positive marginal products and a diminishing
   marginal rate of substitution.

For simplicity, we assume a Cobb-Douglas production function of
the form

$$Q = K^{\alpha} L^{1-\alpha} \tag{12}$$

where

K is the quantity of capital employed

L is the quantity of labor employed

α and $1-\alpha$ are the output elasticities of
capital and labor, respectively, and
$0 < \alpha < 1$.

All prices in this model are measured in terms of the output
good. We assume that the economic system maximizes some form of
utility, subject to real income constraints and prices. Implicit
also is the assumption of a utility function which depends on output,

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Q. This assumption translates into a diminishing marginal rate of subsitution between labor and leisure and labor and capital.

Aggregate factor supply will depend on the net of tax wage rental ratio and the net of tax return specific to the factor in question. The wage rental ratio will capture the non-market activities factor substitution; the own net of tax return will capture the usual supply response. The factor supply equations are thus assumed to follow the form

$$K_s = [\frac{R}{W}]^a \times R^e \qquad a<0, \; e>0 \qquad (13)$$

and

$$L_s = [\frac{W}{R}]^b \times W^e \qquad b<0, \; e>0. \qquad (14)$$

Thus,

$$\frac{K_s}{L_s} = [\frac{R}{W}]^\mu \qquad (15)$$

where

$$\mu = a+b+e \quad (\text{assume } \mu, \; a+e, \; b+e >0). \qquad (16)$$

μ represents the elasticity of substitution in factor supply, which can be obtained from a number of different specifications.

From previous assumptions, the demand for capital, K_d, and labor, L_d, depend on the rental rate paid, R_p, and the wage rate paid, W_p

where

$$R_p = \partial Q/\partial K$$

and

$$W_p = \partial Q/\partial L .$$

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The Soviet economy not being a classic market economy, clearly does not satisfy the assumed conditions precisely. Even the so-called market economies of the West do not satisfy the assumptions in a precise manner. In the Western economies the model does perform well. This implies that the assumptions are more restrictive than necessary. Therefore, failure to satisfy the assumptions is not sufficient to reject the framework. The issue becomes empirical. In a later section the empirical approximations will be presented.

From the above relationships, it can be shown that the net of tax factor returns to labor, W, and to capital, R, respectively are

$$W = \left(\frac{1-\alpha}{1+t_L}\right)\left[\left(\frac{1-\alpha}{\alpha}\right)\left(\frac{1+t_K}{1+t_L}\right)\right]^{\alpha(\gamma-1)} \tag{17}$$

and

$$R = \left(\frac{\alpha}{1+t_K}\right)\left[\left(\frac{1-\alpha}{\alpha}\right)\left(\frac{1+t_K}{1+t_L}\right)\right]^{(\alpha-1)(\gamma-1)} \tag{18}$$

and the net wage/rental ratio is

$$\frac{W}{R} = \left[\left(\frac{1-\alpha}{\alpha}\right)\left(\frac{1+t_K}{1+t_L}\right)\right]^{\gamma} \tag{19}$$

where

$$\gamma = \frac{1}{1+\mu} \qquad (\gamma > 0).$$

These equations imply that the net of tax factor returns, W and R, depend on the level of the taxes on labor and capital, t_L and t_K, respectively, the output elasticities of production of labor and capital, as well as the slopes of the supply curves of both labor and capital.

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Theorem 1:   *Increases in taxes tend to reduce the net of tax factor returns.*

This theorem establishes the proposition in economics that if taxes on a factor are raised (e.g., to support a higher level of defense spending), the less will be the returns to the factor employed (i.e., the higher will be the burden borne by that factor).

There exists a precise correspondence between factor and product taxes. If the tax on a product is increased, less of that product will be demanded. This translates into a reduction in the demand for the input factors. The first order effect of the reduced demand at the same total factor supply is to reduce the wage and rental rates. The lower rates induces an increased demand for the factors. This process continues until equilibrium is established. At this equilibrium point, less of the input factors will be employed, and the rates received at these factors will be less than the original returns.

The relationships between the returns to the factors of production and the tax rates on the factors can be found by differentiating the equations for the wage rate and the rental rate (Equations 17 and 18) partially with respect to (w.r.t.) t_L and t_K, respectively and evaluating the signs of the resulting expressions gives

$$\frac{\partial W}{\partial t_L} = - [\alpha(\gamma-1)+1] \left(\frac{W}{1+t_L}\right) < 0 \qquad (20)$$

$$\frac{\partial W}{\partial t_K} = \alpha(\gamma-1) \left(\frac{W}{1+t_K}\right) < 0 \qquad (21)$$

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$$\frac{\partial R}{\partial t_L} = -(\alpha-1)(\gamma-1) \left[\frac{R}{1+t_L}\right] < 0 \tag{22}$$

$$\frac{\partial R}{\partial t_K} = [(\alpha-1)(\gamma-1)-1] \left[\frac{R}{1+t_K}\right] < 0. \tag{23}$$

The above equations show that increases in the tax rates on capital and labor needed to finance increased defense expenditures unambiguously reduce the net of tax factor returns. The magnitude of the negativity of the above equations depends largely on the specifics of the model (factor supply equations and production function).

If one assumes that $0 < \alpha$, $\mu < 1$, then $.5 < \gamma < 1$. As the output elasticity for capital, α, increases, holding supply elasticity constant, the change in the wage rate w.r.t. the change in the tax on labor decreases. If the elasticities for capital (α) and for supply (γ) were both equal to zero, then increases in the tax on labor would not change the wage rate.

Similarly, an increase in the elasticity for capital, holding constant the supply elasticity, would (1) increase the change (negative) in the wage rate for a given change in the tax on capital, (2) decrease the change in rental rates for a change in the tax on labor and, (3) increase the change in rental rates for a given change in the tax rate on capital.

Increasing the supply elasticity would produce changes in the returns to capital and labor in the same direction as changes in the elasticity of capital produced, for changes in the tax rates on capital and labor.

Substituting for the equilibrium net of tax factor returns into the factor supply equations, the equilibrium quantities of each factor employed are determined.

Thus, the equilibrium capital employment,

$$K = \left[\frac{\alpha}{1+t_K}\right]^e \left[\left(\frac{1-\alpha}{\alpha}\right)\left(\frac{1+t_K}{1+t_L}\right)\right]^{e(\alpha-1)(\gamma-1)-a\gamma} \tag{24}$$

the equilibrium labor employment,

$$L = \left(\frac{1-\alpha}{1+t_L}\right)^e \left[\left(\frac{1-\alpha}{\alpha}\right)\left(\frac{1+t_K}{1+t_L}\right)\right]^{e\alpha(\gamma-1)+b\gamma} . \tag{25}$$

and the capital/labor ratio,

$$\frac{K}{L} = \left[\left(\frac{1-\alpha}{\alpha}\right)\left(\frac{1+t_K}{1+t_L}\right)\right]^{-\gamma(a+b)-\gamma e} \tag{26}$$

Theorem II: Increases in taxes on either factor reduce each factor's employment.

Differentiating the equations for capital and for labor partially w.r.t. t_L and t_K, respectively, one has

$$\frac{\partial L}{\partial t_L} = - \left[e\alpha(\gamma-1)+b\gamma+1\right] \left[\frac{L}{1+t_L}\right] < 0 \tag{27}$$

$$\frac{\partial L}{\partial t_K} = \left[e\alpha(\gamma-1)+b\gamma\right] \left[\frac{L}{1+t_K}\right] < 0 \tag{28}$$

$$\frac{\partial K}{\partial t_L} = -\left[e(\alpha-1)(\gamma-1) - a\gamma\right] \left[\frac{K}{1+t_L}\right] < 0 \tag{29}$$

$$\frac{\partial K}{\partial t_K} = \left[e(\alpha-1)(\gamma-1) - a\gamma-1\right] \left[\frac{K}{1+t_K}\right] < 0 . \tag{30}$$

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These equations show that equilibrium factor employment (capital and labor) decrease with increases in the tax on the other factor (say, capital), as well as with increases in the tax on the factor (labor, in this case). Note that the magnitude of the cross effects depends on the specifics of the model.

The elasticities, a and b, in the above equations are always less than zero. The supply elasticity, γ, is greater than zero. The cross terms bγ and aγ are thus always negative. These terms tend to (1) reduce the change in the return to labor and, (2) increase the change in the return to capital (both for a given change in the tax rate on labor) and, (3) increase the change in the return to labor and, (4) decrease the change in the return to capital (both for a given change in the tax rate on capital).

Corollary: *Taxes will have an effect on the proportions of inputs employed.*

Differentiating the equation for the capital/labor ratio partially w.r.t. t_K and t_L, respectively, gives

$$\frac{\partial(K/L)}{\partial t_K} = -[\gamma(a+b) + e\gamma] \left(\frac{K/L}{1+t_K}\right) < 0 \qquad (31)$$

$$\frac{\partial(K/L)}{\partial t_L} = [\gamma(a+b) + e\gamma] \left(\frac{K/L}{1+t_L}\right) > 0. \qquad (32)$$

These equations show that factor intensity is affected by changes in the tax rates on capital and labor. Increases in the tax rate on capital decreases the capital/labor ratio. Increases in the tax rate on labor would unambiguously increase the capital/labor ratio,

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given any tax rate on capital. This, in effect, enhances the substitutability of capital for labor in the economy. Thus, the above equations show that increases in the tax rates on labor would lead to a more intensive use of capital; increasing the economy's capital/labor ratio, while increasing the tax on capital, would produce the opposite effect.

From the basic Cobb-Douglas production function (equation 12), it can be shown, using the previous assumptions, that

$$Q = \left[\frac{1-\alpha}{1+t_L}\right]^e \left[\left(\frac{1-\alpha}{\alpha}\right)\left(\frac{1+t_K}{1+t_L}\right)\right]^{-(a\gamma+e) - \gamma b(\alpha-1)} \tag{33}$$

which leads to

Theorem III: *Increases in taxes (spending for defense) while not lowering either tax rate reduces output.*

This theorem establishes one of the most fundamental propositions of classical economics, that if taxes on a factor (which are equivalent to product taxes) are raised, there will be less of that product. Differentiating the above quantity relationship w.r.t. the tax rates on labor and capital, t_L and t_K, respectively, yields

$$\frac{\partial Q}{\partial t_L} = - [e - \alpha(a\gamma+e) - \gamma b(\alpha-1)] \left[\frac{Q}{1+t_L}\right] < 0 \tag{34}$$

$$\frac{\partial Q}{\partial t_K} = - [\alpha(a\gamma+e) + \gamma b(\alpha-1)] \left[\frac{Q}{1+t_K}\right] < 0 \tag{35}$$

$$d = \frac{\partial Q}{\partial t_L} dt_L + \frac{\partial Q}{\partial t_K} dt_K < 0. \tag{36}$$

These equations show that the change in output with respect to a given change in the tax rate on labor or capital, required to support

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a changing level of defense spending is negative. The net effect of increasing defense expenditures is a reduction in output. Conversely, a decrease in defense spending would increase output.

The change in output depends in both cases on the levels of the taxes, t_L and t_K, the slopes of the supply curves of labor and capital, as well as the output elasticities of labor and capital. Thus, it follows that the higher the elasticities of supply of labor and of capital, the lower will be the change in output resulting from a given increase in defense spending. These equations confirm the neoclassical conclusions that defense spending induced tax increases tend to reduce output.

Theorem IV: *There exists a tradeoff between the taxes on labor and capital necessary to maintain output at a given level.*

This theorem is concerned with changes in the tax rates on the factors of production at a given output level (i.e., on an isoquant), where $dQ = 0$ and

$$\left.\frac{dt_L}{dt_K}\right|_{Q \,=\, const} = -\frac{\partial Q/\partial t_K}{\partial Q/\partial t_L} \tag{37}$$

$$= -\left(\frac{1+t_L}{1+t_K}\right)\left[\frac{\alpha(a\gamma+e) + \gamma b(1-\alpha)}{\alpha(a\gamma+1) + \gamma b(1-\alpha) - e}\right] \tag{38}$$

$\left.\frac{dt_L}{dt_K}\right|_Q$ is termed the Marginal Rate of Factor Tax Substitution (MRFTS).

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The marginal rate of factor tax substitution is defines as the rate at which the economy can substitute the tax on a given factor of production for a tax on another factor, while keeping output constant.
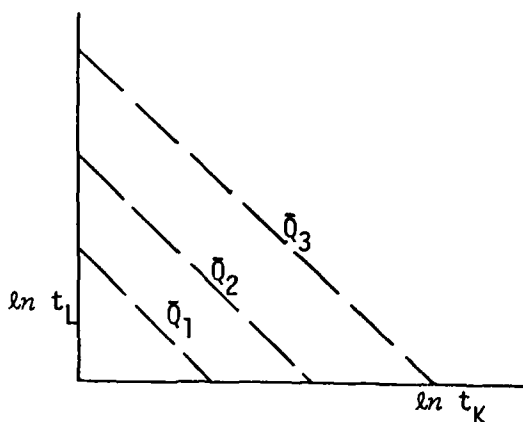
FIGURE 1

MARGINAL RATE OF FACTOR TAX SUBSTITUTION

Figure 1 depicts graphically the theoretical relationships between factor rates, holding output constant. The slopes of the curves are the MRFTS.

Theorem V: *There exists a tax structure that maximizes government revenues.*

First order conditions imply that G is maximized when

$$\frac{\partial G}{\partial t_L} = WL + t_L \frac{\partial(WL)}{\partial t_L} + t_K \frac{\partial(RK)}{\partial t_L} = 0 \qquad (39)$$

$$\frac{\partial G}{\partial t_K} = t_L \frac{\partial(WL)}{\partial t_K} = RK + t_K \frac{\partial(RK)}{\partial t_K} = 0. \qquad (40)$$

Using equations 17, 18, 19, and 26, in (39) and (40) above, and simplifying, one has

$$\frac{\partial G}{\partial t_L} = WL \left[1 - \frac{(1+B+e)\ t_L}{1+t_L} \right] - \frac{t_K\ ARK}{(1+t_L)} = 0 \tag{41}$$

$$\frac{\partial G}{\partial t_K} = \frac{t_L}{(1+t_K)} BWL + RK \left[\frac{(A-1-e)\ t_K}{1+t_K} \right] + 1 = 0 \tag{42}$$

where

$$A = (\alpha-1)(\gamma-1)(1+e) - a\gamma$$

$$B = \alpha(1+e)(\gamma-1) + b\gamma.$$

Defining

$$T_L = \frac{t_L}{1+t_L} \tag{43}$$

and

$$T_K = \frac{t_K}{1+t_K} \tag{44}$$

and substituting into equations 41 and 42 gives

$$T_L = - \frac{[A-(1-\alpha)(1+e)]}{[(1-\alpha)(1+e)]} \tag{45}$$

$$T_K = \frac{[\alpha(1+e) + B]}{\alpha(1+e)} . \tag{46}$$

From equations 45 and 43, one has

$$t_L = - \frac{[A-(1-\alpha)(1+e)]}{A} . \tag{47}$$

Similarly, from equations 46 and 44, one has

$$T_K = - \frac{[B+\alpha(1+e)]}{B} . \tag{48}$$

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Equations 47 and 48 illustrate the tax rates on labor and capital which maximize government tax revenues. Using these tax rates in the expression for government tax revenues, one obtains the maximum government tax revenues, G_{max} as

$$G_{max} = \frac{1}{(1+e)} \frac{A}{1+e}^e \left[\frac{-A}{B}\right]^{-c} \tag{49}$$

or

$$G_{max} = \frac{1}{(1+e)} \left[\frac{e+B}{1+e}\right]^e \left[-(1 + \frac{e}{B})\right]^{-c} \tag{50}$$

$$c = \alpha(a\gamma+e) + \gamma b(1-\alpha).$$

The corresponding output level (with this tax structure) is

$$Q = \left(\frac{A}{1+e}\right)^e \left(\frac{-A}{B}\right)^{-c} \tag{51}$$

$$Q = e+\alpha(\gamma-1)(1+e) + b\gamma \left(\frac{-A}{B}\right)^{-c}. \tag{52}$$

Equations 49 and 50 show that both the government tax receipts and output depend on the supply and output elasticities of the factors of production.

Corollary: *There exists a trade-off between the tax rates on labor and capital necessary to maintain a given level of government tax receipts (defense spending).*

By definition, the total change in government tax receipts, dG is given by the equation

$$dG = \partial G/\partial t_L \, dt_L + \partial G/\partial t_K \, dt_K \tag{53}$$

On any given iso-defense spending curve, dG = 0. Therefore,

$$\left.\frac{dt_L}{dt_K}\right|_{G = const} = - \frac{\partial G/\partial t_K}{\partial G/\partial t_L} \tag{54}$$

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$$\frac{dt_L}{dt_K}\bigg|_{\bar{G}} = - \frac{\alpha}{1-\alpha} \frac{1+t_L}{1+t_K} \left[\frac{\frac{1-\alpha}{\alpha} BT_L + (A-1-e) T_K + 1}{1 - (B+1+e) T_L - AT_K \frac{\alpha}{1-\alpha}} \right] \tag{55}$$

$$A = [\alpha-1] \, [\gamma-1][e+1] - a\gamma$$

$$B = \alpha \, [\gamma-1] \, [e+1] + b\gamma$$

$$T_L = \frac{t_L}{1+t_L}, \qquad T_K = \frac{t_K}{1+t_K}.$$

$\dfrac{dt_L}{dt_K}\bigg|_{\bar{G}}$ is termed the Marginal Rate of Factor Tax Substitution (MRFTS).

The marginal rate of factor tax substitution is simply the rate at which the government trades off the tax on labor for the tax on capital while maintaining total tax revenues (defense spending) constant. The MRFTS depends on the supply and output elasticities of the factors of production as well as the levels of the taxes on capital and labor.

Figure 2 illustrates several important relationships. First, at any given level of defense spending there exists two unique sets of tax rates on capital and labor, t_K and t_L, which will produce the necessary amount of revenue.

Second, holding defense spending constant gives, in general different combinations of tax rates which will maximize output (e.g., point (1) on Figure 2), maximize total returns to labor (e.g., point (2) and maximize the return to labor (e.g., point (3)). Figure 2 is

a general depiction of the relationships and is not meant to imply a
specific relationship between the particular factors and quantities.
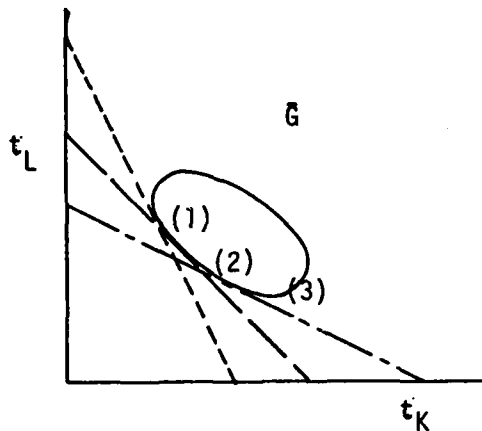
FIGURE 2

MARGINAL RATE OF FACTOR TAX SUBSTITUTION

Model Conclusions

In this general equilibirum analysis combining the supply of
factor services with aggregate demand for goods and services, the
effects of factor taxes (imposed strictly for purposes of defense
spending) on output and returns to the factors of production are
explored.

The analysis shows that the levels of output, factor employ-
ment (capital and labor) and the returns to these factors depend on
the level of the tax rates on capital and labor. The analysis also
shows that increases in factor taxes reduce output. Thus, given the
equivalence of product and factor taxes, it follows that if taxes on

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a product are raised, there will be less of that product. Likewise, if subsidies for a product are increased, in general, there will be more of the subsidized product. Therefore, taxes on commodities discourage their production, while subsidies to products encourage their production.

The optimal tax structure that maximizes output at a given level of defense expenditures depends on the supply elasticities of capital and labor, the level of government spending, and the output elasticities of the factors of production. The maximum output, in turn, depends on the supply output elasticities of these factors. Thus, if output maximization is the goal of government, the government should tax more highly the factor with relatively lower elasticity of supply, while the more elastic factor should be taxed at a lower rate.

At a given level of defense spending, the maximum net of tax return to labor depends on the supply and output elasticities of the factors. The results show that if the government wishes to maximize the net of tax returns to labor, or total labor income net of taxes, then the more inelastic factor should be taxed more.

Applications

An explicit burden analysis for the Soviet Union as well as for the United States using the relationships developed in this chapter is feasible. This analysis would require certain basic tax rate and elasticity information. Such required data are available from the considerable amount of published and externally developed information

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on the respective economies, especially the pioneering work of Bergson and Becker.

Such an analysis for the Soviet Union would be inherently Soviet based, depending solely on Soviet relationships and data. As such, it is directly compatible with budget and production based approaches to the estimation of Soviet defense expenditures.

Current budgetary approaches to estimating Soviet defense spending rely, in general, on an analysis of production and published budget information. By maintaining a Soviet perspective such approaches would inherently tend to approximate more closely the data and analyses used by Soviet decision makers. In practice, such approaches suffer from numerous deficiencies; a topic covered in detail in Chapter II. The framework developed for analyzing the concept of the burden of defense expenditure developed in this chapter offers another method of using Soviet based information to understand the levels and trends of Soviet defense expenditures.

For example, if data exists from which one can estimate the various production functions and elasticity variables, and reasonably accurate information exists for non-defense spending, then the level of defense spending can be deduced as a residual. But this residual, despite its lack of detail, would be derived from different data sources and from a different analysis than that currently used. More importantly, the time series of these estimates would provide additional information concerning changing rates of Soviet defense expenditures, and at least implicitly, changing Soviet perceptions as

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to the value of this defense spending. The value of this form of
analysis is primarily its ability to identify internal inconsistencies
with other estimates of levels and trends of defense expenditures.

Additionally, this form of analysis would be useful in
quantifying the breadth of ranges of input factors which might lead
to a given force level. If widely varying input mixes can produce
reasonably similar outputs (results), then economic intelligence is
less useful and direct observation of results should be emphasized.
On the other hand, if analysis and evidence indicates that observable
changes in the mix lead to sharply different outputs, then economic
intelligence is more important and such estimates should be as sharp
as possible. Analyses such as those proposed in this chapter may
help resolve this question.

The Subjective Concept of the Burden of
Defense Expenditures

In addition to the direct costs which a country must bear to
support a defense establishment, one must consider certain indirect
costs. In the case of the Soviet Union, these indirect costs are highly
significant.

The vulnerability of Soviet industry in World War II convinced
the Soviet leadership of the dangers of concentrating military and
civilian industries in insecure regions of the country. The resulting
movements of people and equipment to interior regions have levied a
heavy burden on both individuals and production efficiency. Harsh
climatic conditions, poorly developed and expensive infra-structure,

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and psychologically depressing environments add to the objective burden of defense. The willingness of Soviet leaders and citizens to bear this burden reflect their perceived utility of military and industrial strength.

The objective analysis of the tradeoffs and lost opportunities that a country must endure to support a given level of defense expenditures does not consider that country's perception of the strains of such spending. It is this perception which influences the policies of Soviet leaders and the support given these policies by the general populace.

The social, economic and ideological struggle between the United States and the Soviet Union is a protracted one. It is this aspect of the struggle which increases the importance of the country's willingness to bear the continued burden of defense expenditures. The cumulative effects of lost output, decreased incentives and reduced growth weigh heavily in the objective concept of defense burden. Likewise, the psychological commitment of the country over a long period is the major factor in understanding that country's perception of the burden of continuing defense expenditures.

The long term nature of the struggle with the United States reduce the Soviet's uncertainty as to the ideological purpose and role of military conflict and the eventual triumph of Communism. While the paths to such events are not specified in the doctrine, but left to the practicality of the given situation, the eventual outcome is unambiguously defined. These factors strongly affect the perceptions

of Soviet leaders and, to some extent, the general populace, concerning the necessity of continued high levels of defense spending.

The Communist struggle against the French and the United States in Vietnam was not eventually decided in favor of the side which was best able to bear the objective burden of continued military operations. It was decided for the side which was best able to bear what is *perceived* to be the burden of the conflict. So too between the United States and the Soviet Union will the perceptions of the power and the burden of military forces be increasingly more important as the time horizon lengthens.

But, the Soviet perceptions of the role of military power is not unchanging. To understand the burden of defense spending to the Soviets one must understand the Soviets, their goals and aspirations, and their value system. It is clear that the Soviet citizens prefer increased output of consumer goods, and that their leaders would like to supply those goods. What is not clear is the potential reactions of both citizens and the leaders to political and economic events (e.g., oil shortages, see U.S. CIA, 1977a) which could reduce the standard of living if military expenditures are maintained at current or higher levels.

An accurate comparison of all aspects of military power cannot be made short of actual conflict. This does not decrease the importance of analyzing force levels, performance characteristics and employment and support strategies. To these must be added the perceptions of military power and burden. These perceptions are even more

important for conflicts short of physical warfare. The political
utility of military power perceived by Soviet leaders in controlling
these conflicts affects their willingness to bear the high burdens of
defense expenditures. These considerations also color the Soviet's
actions concerning arms control and international cooperation and
development. Once again, care must be exercised to separate short term
opportunism from long term commitment.

It is not the purpose of this paper to attempt to cover in any
significant fashion all possible aspects which affect the Soviet per-
ception of the burden of defense expenditures. It is clear that the
study of such burden must be conducted in a Soviet perspective. It
must include an analysis of Soviet philosophies, Soviet history, and
Soviet perceptions. It is only when the subjective and objective
concepts of burden are combined that one can fully comprehend the role
of military power and military spending in the Soviet economic and
political systems.

CHAPTER V

AN ALTERNATIVE METHODOLOGY

In earlier chapters details of the major methodologies currently used to estimate Soviet defense expenditures were presented. These models fall under two general categories. The first, Direct Costing, relies on the pricing of observed quantities of defense hardware. Non-observed support and research and development costs are then added to produce the final aggregate estimate.

The second basic category relies on published Soviet budgetary and/or production data. The most elementary form adds a portion of the "Science" budget to the published "Defense" budget item. The resulting figure is the estimate of Soviet defense spending. This contrasts with the "Unconventional Approach" advocated by Lee in which national security durables are derived as a residual from the Metal Working and Machine Building sector. A variant of the published "Defense" budget is used as a proxy for the total operations and maintenance costs. Research and Development expenditures are estimated by the input costs of the R&D enterprises.

As an alternative, an aggregate estimate of the levels of Soviet defense spending, and, more accurately, the growth rates of such spending, can be derived using a completely different approach. This chapter will develop this methodology and present the empirical results

which indicate the validity of the proposed model.

Basically, the essence of this model is that taxes reduce the quantity of the taxed commodity. Soviet defense efforts are part of the total tax on Soviet output. The remainder of the tax is the nondefense portion of the Soviet budget. These figures are available and considered relatively accurate. Therefore, Soviet output will depend upon Soviet taxes, i.e., total State spending. In growth terms, Soviet output growth will depend directly on Soviet spending growth. With knowledge of Soviet output growth and the growth in nondefense spending, growth in Soviet defense efforts is estimable. While in any one year measurement errors and stochastic disturbances may make a point estimate unreliable, the trends still could be fairly accurate.

In Chapter IV on the burden of defense expenditures a general equilibrium model of the economy was developed. The basic differences between this model and standard models is that the burden model allows for a variable supply of factors of production in response to economic incentives. A firm's willingness to hire an additional unit of labor or of capital is a function of the additional costs of that unit. Similarly, the decision of a worker to provide his labor or an investor his capital is a function of the after-tax wage or rental rate received. Taxes drive a "wedge" between the wage or rental rate paid and that received. Higher taxes reduce the demand for the taxed quantity as well as the supply of that quantity.

Changes in government spending (i.e., taxes) can then be used to explain changes in aggregate output. The changes in spending

implied by changes in output, however, captures more than just the acknowledged cost of government programs. For example, following the Vietnam war the United States' force structure changed from a major reliance on conscription to an all volunteer structure. Despite a decrease in 1.5 million men, personnel costs rose by $10 billion. A major portion of the additional costs reflected the explicit recognition of the difference between the opportunity cost value of the conscripted soldier and what he was actually paid. This difference in cost was a tax borne by the conscript. During the period of the draft, then, the true costs of the U.S. defense expenditures were underestimated by the value of this tax on the conscripts.

This implicit tax cost is even greater in the Soviet case. Brubaker (1973) estimates that since the mid-1950s the number of Soviet conscripts has ranged between 2.0 and 2.5 million out of a total force of 3-4+ million. He further estimated the total value of this implicit tax at 10 percent of the military budget (5 percent of the current estimated Soviet defense series). Obviously, any estimate of the real costs of Soviet defense spending must take such indirect costs into account.

By relating changes in government spending to changes in output one directly captures the opportunity costs of this spending in terms of total output. By its spending activity the government removes resources from the economy. The value of these resources are measured in terms of the reduced consumption and investment opportunities. This is the burden paradigm in which lost total output is the measure of the

costs of defense expenditures.

Other indirect costs in addition to that of conscription are also captured. Defense activities have priorities over civilian efforts in the Soviet competition for trained manpower and high technology capital equipment. Also, the costs charged military users may be less than that charged nondefense purchasers. These effects are nearly impossible to capture directly. They can, however, be captured by measuring their effect on total output.

Three different forms of the model relating changes in defense spending to changes in output and changes in government expenditures were developed and exercised. The basic equation for the first form solved for the effects of defense and nondefense spending on output. This relationship more intuitively shows how output is affected by government expenditures.

The second form was the least squares model using changes in defense spending as the independent variable. Both the first and the second forms were fitted to U.S. data for the period 1944-1977.

The last form was identical to that of form two except that the data were fitted from the 1960-1977 period. Differences in the coefficients between the last two forms are an indication of the temporal stability of the model.

The first model, developed using changes in output as the independent variable, overpredicted Soviet defense spending changes and is inappropriate for our purposes. The second model also tended to overpredict, but by a lesser amount. This model is also unusable

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for our purposes, since the estimates were inconsistent with reliable estimates of total output and nondefense expenditures. The results using the last form, based on 1960-1977 data, are least subject to distortions caused by intertemporal variations in parameter coefficients and other confounding effects. The results produced by this model are both intuitively reasonable and consistent with other data.

This last model form was exercised using various estimates of Soviet GNP series in constant and current prices. The best available data consisted of current price GNP series at factor costs produced by G.E. Tempo and a corresponding constant price GNP series made available by the CIA. The basic results were reenforced by a final estimate for the period 1970-1975 based on a British current price GNP series and the CIA constant price series. Data for other years and specifics of the British series are not available.

Based on the available Soviet data, the following conclusions can tentatively be made.

The growth rate of Soviet defense expenditures over the period 1966-1973 ranges from slightly higher to significantly higher than predicted by the CIA and generally just slightly lower than estimated by Lee. The range of results is due to the different GNP series used in the alternative estimates. The model shows that the growth rate of defense spending was not constant during this period. The rate in the latter half of the 1960s was significantly greater than that in the early 1970s. The growth rate in the earlier period was somewhat comparable to that estimated by Lee. However, in the latter period the

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estimated rate is much closer to that predicted by the CIA.

Model Development

Accurate Soviet economic data do not exist for a sufficiently long period to allow their use in model development. Instead, our initial development and model verification were performed using U.S. data.

The validity of using a model developed from U.S. data to predict Soviet relationships may well be reasonable when one considers the fundamental nature of the relationships included in the model. Economic theory explicitly contends that there is a direct and measurable relationship between changes in government spending and changes in output. The economic behavioral causes of this relationship reflect the incentive aspects of government spending and the accounting procedures used to aggregate and report the data. As shown in the chapter on the burden of defense expenditures, the Soviet economy may well respond to tax burdens in a manner similar to that of the U.S. The fact that defense spending is included as a direct component of GNP does not change the basic structure of the relationships, but it does affect the value of parameters in the regression equations. Accounting procedures used to aggregate and report economic data do vary between the U.S. and the Soviet Union. Thus, to employ a model developed using U.S. data for the Soviet Union, Soviet data must be reconstructed to reflect U.S. reporting practices. Systematic errors in this conversion process most likely will not have a significant effect on the results, since the

model deals primarily in changes. Nonsystematic errors will, of course, affect the accuracy of the model.

Constant price GNP is used as the measure of real output. Other variables in the regression models are divided by current GNP. The resulting new variables are thus normalized to reflect a measure of the government spending "wedge."

Reconstructed Soviet GNP series are reported in both established prices and factor costs. Basically, the established price series reflect actual end item market prices in the Soviet Union. However, due to subsidies, turnover taxes, and various profit charges, established prices are not as relevant as the factor cost series. Factor cost series are more appropriate for the purpose of gauging resource utilization.

A number of estimated constant established price GNP series exists for the Soviet Union. Constant factor cost series, because of the laborious reconstruction involved, are not as numerous. For our study we used constant established price and factor cost series provided by the Central Intelligence Agency (CIA). Current price series are usually calculated by applying a particular labor or material deflator to each subset of the GNP accounts. Unfortunately, Soviet deflator series are biased. This bias results from the limited number of products used in computing the series and the nonmarket prices charged for certain items.

Two complete current price GNP series were available for this study. Lee (1978) produced a series in established prices that covered

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the entire 1965-1975 period. A partial series in established prices covering the period 1970-1975 was provided by the CIA, andproduced by an unreferenced British source.

The most compatible current price GNP series was produced by G.E. TEMPO. This series was at factor cost and was compatible with the constant price, factor cost series of the CIA.

For greater consistency, the CIA established price GNP series was used for the constant price GNP figures and the Lee or British current price GNP series in established prices was used for the current figures to produce two of the estimates. The CIA constant price series at factor costs and the TEMPO current price series at factor cost are considered the best available data for our study. These series were used to produce the "best" estimate using the alternative methodology.

The degree to which inflation exists in the Soviet Union is a controversial issue which, along with Soviet pricing policies, distorts the differences between the constant and current series. Soviet prices are often only adjusted when the product undergoes a technical change or when a price reform is instituted. The "current" price thus may reflect a "constant" price more than it does the opportunity cost of the item. In recognition of this problem, the current series in established prices was used with the CIA's constant price series at factor cost to provide secondary estimates.

Variables

The dependent variable selected for the initial model was the $\Delta\log_e(GNP/P)$. GNP was measured in constant terms and P was taken as the working age population (ages 20-64). The $\Delta\log_e$ operator takes the differences between the logarithm (base $e\approx2.718$) of the value in the current period and the value in the prvious period. In the limit the result is exactly the percentage change in the value over the period. The functional form of the dependent variable was dictated by the multiplicative form of the regression equation. The logarithm differencing, as will be shown, satisfactorily corrected for auto-correlation in our trended series. Using first differences of the dependent variable, $\Delta(GNP/P)$, i.e., the value in the current period minus the value in the previous period, will successfully remove the serial correlation in linearly trended series, but not in exponential growth series. Using a population deflator partially corrects the auto-correlative tendencies in our GNP series. It also removes the effects of population from the final relationship. Satisfactory stationarity was achieved using the delta logarithm form.

GNP was measured in constant 1972 dollars for the output measure, thus removing the effect of different inflation rates over the period of the model, 1944-1977.

Two independent variables were used in the model. The first variable was the change in the defense wedge. This was calculated at the first difference of defense expenditures, deflated by current GNP, i.e., $\Delta(DEF/GNP)$. Since one is interested in the output value of real

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resources taken for defense, the same price deflator applies to both the numerator and the denominator terms. The resulting ratio is thus identical with that obtained by deflating real defense and real GNP series.

The second independent variable used was the change in total nonmilitary government spending, deflated by current GNP, i.e., $\Delta\{(Govt-Def)/GNP\}$. Total government spending was calculated by summing total government expenditures, federal, state, and local, minus grants-in-aid. The resulting value is similar to the standard burden measure of nonmilitary government spending, i.e., spending divided by GNP.

In this hypothesis, changes in government spending induce changes in total output. Since one is ultimately interested in the relationship which includes changes in defense spending and changes in total output, total government spending was divided between defense and nondefense. To this extent, this model can be considered to be causal. The independent variables were preselected as a result of the basic hypothesis. The coefficients of these variables were not determinable *a priori*.

Since nondefense spending consists largely of transfer payments from producers to recipients on a basis other than production, a negative effect on output would be predicted. The sign of the defense spending coefficient is not as easily predetermined. Defense spending does have a negative substitution effect (between labor and leisure) on the part of the recipient, as does nondefense spending. However, since defense is a direct component of GNP, the two series will tend to move

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in the same direction, even though such spending may well reduce private output. The effects of this accounting anomaly should be reversed in future periods.

The basic hypothesis does not presuppose any lag structure between the effects of changes in the spending measures on output. When yearly data were used only concurrent values of the independent variables were statistically significant. Current values of both defense and nondefense spending, deflated by GNP, were also tested in the model. Again, the coefficients were statistically insignificant. (All tests of statistical significance were performed at the 0.05 level.)

U.S. Output Model

Equation 56 is the calculated regression model relating output changes to changes in defense and nondefense spending. Values of the t statistic for each predictor variable are in parentheses below the corresponding variable. The F statistic for the overall regression equation was 159.05.

$$\Delta\log_e(GNP/P) = .034195 - 2.131\Delta\{(NDef)/GNP^1\} + \qquad (56)$$
$$(10.79) \qquad (7.33)$$
$$0.49844\Delta\{Def/GNP^1\}$$
$$(6.21)$$

where

GNP is measured in \$ billions of 1972 dollars

GNP^1 is measured in \$ billions of current dollars

P is the working age population (20-64) in millions

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Def is total defense expenditures in $ billions (current)

(NDef) government is total nonproduction spending for other
than defense in $ billions (current)

Durbin-Watson statistic = 2.065, Mult. R = 0.9532

First order autocorrelation coef. = -0.043

Standard error of auto. coef./random model = 0.169.

It should be noted that, as predicted, changes in total output
are negatively related to changes in nondefense spending. Changes in
defense spending are positively related to changes in total output, but,
as discussed previously, this is partially due to the income effect be-
tween defense spending and GNP.

Figure 3 shows a plot of the standardized values of the
residuals. Visual inspection of the plot does not indicate sufficient
changes in variance to reject the assumption of homoskedasticity,
despite the slightly larger residuals in 1952 and 1954. The early 1950s
were a period of large changes in defense spending and total output.

Serial correlation among the residuals was tested using the
Durbin-Watson (d.w.) statistic. Durbin and Watson have calculated
lower and upper bounds of this statistic, $d.w._l$ and $d.w._u$, that are
independent of the observed data. If the calculated statistic falls
below $d.w._l$ positive serial correlation is indicated. Above $d.w._u$ the
absence of positive serial correlation is indicated. Between $d.w._l$
and $d.w._u$ the results are inconclusive. Under the null hypothesis--no
autocorrelation--the distribution of the Durbin-Watson statistic is
symmetrical with a mean of two. Thus, using $4-d.w._l$ and $4-d.w._u$ one

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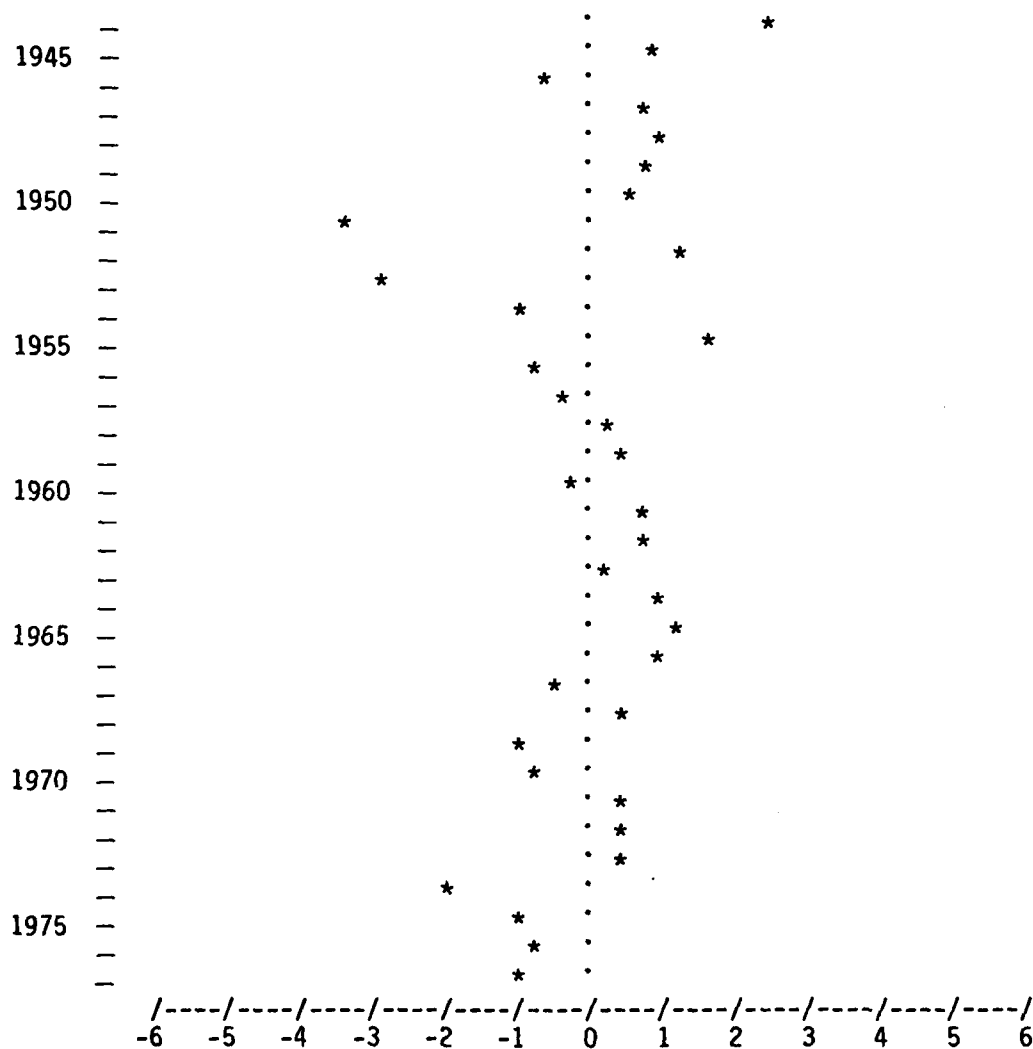
FIGURE 3

Plot of Standardized Residuals

(U.S. GNP 1944--1977)

can test for negative serial correlation.

In our study $T = 32$ and there are two independent variables. The appropriate values of the Durbin-Watson statistic are $d.w._l = 1.30$ and $d.w._u = 1.58$. The calculated value of 2.07 indicates a lack of both positive and negative serial correlation.

Figure 4 shows the plot of the coincident values of the actual changes in output (dependent variable) and the calculated values for the period 1944-1977.

U.S. Defense Model

The form of the equation (56) model relates directly the effect on real output of changes in defense and nondefense spending. Although causality is more easily visualized in this form, it is changes in defense spending, not changes in output that one wants to predict.

The first alternative estimation model simply solves equation 56 for the changes in defense spending, deflated by current GNP. The resulting equation is

$$\Delta\{Def/GNP^1\} = -0.68604 + 2.00626 \ \Delta\log_e\{GNP/P\} + \qquad (57)$$
$$4.27534 \ \Delta\{(NDef/GNP^1\}$$

The regression equation (equation 56) was then recomputed with the first difference of defense spending per nominal GNP as the dependent variable. The nondefense spending variables used in the output model development was tested for inclusion. The resulting least squares equation is ($F = 69.37$, $R = 0.30740$).

Scaled by 10**3
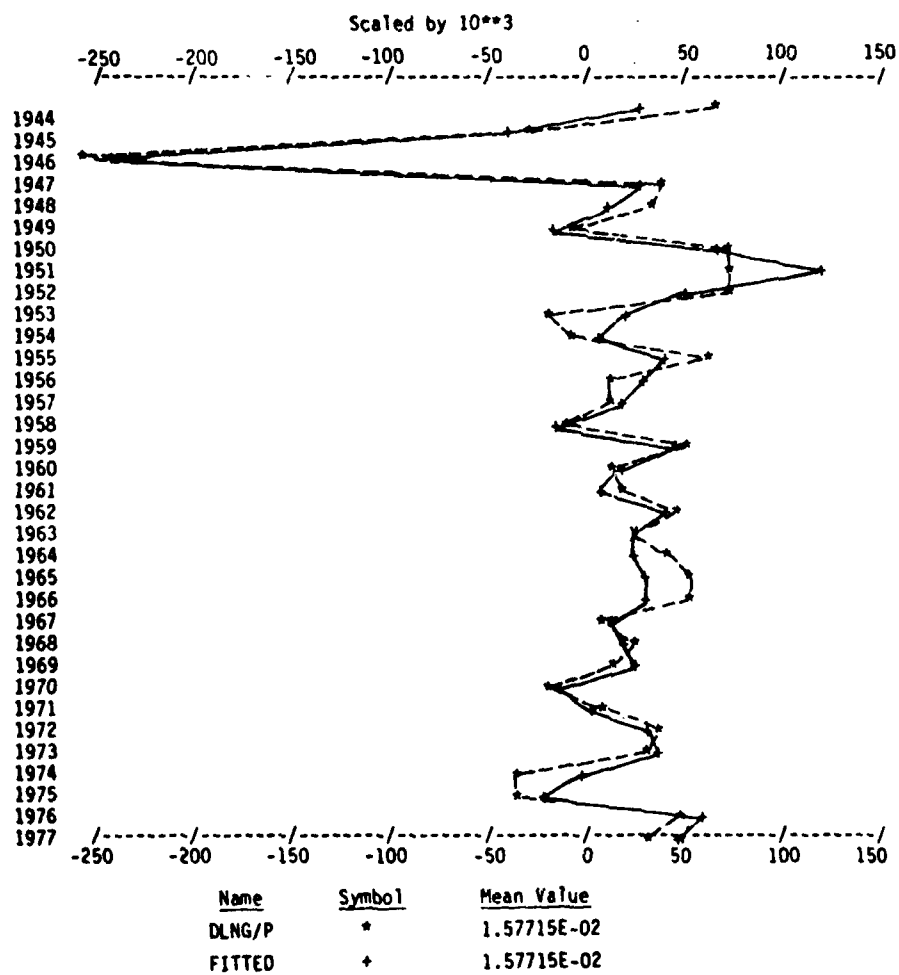
FIGURE 4

Actual versus Fitted Values

(U.S. GNP 1944--1977)

Name	Symbol	Mean Value
DLNG/P	*	1.57715E-02
FITTED	+	1.57715E-02
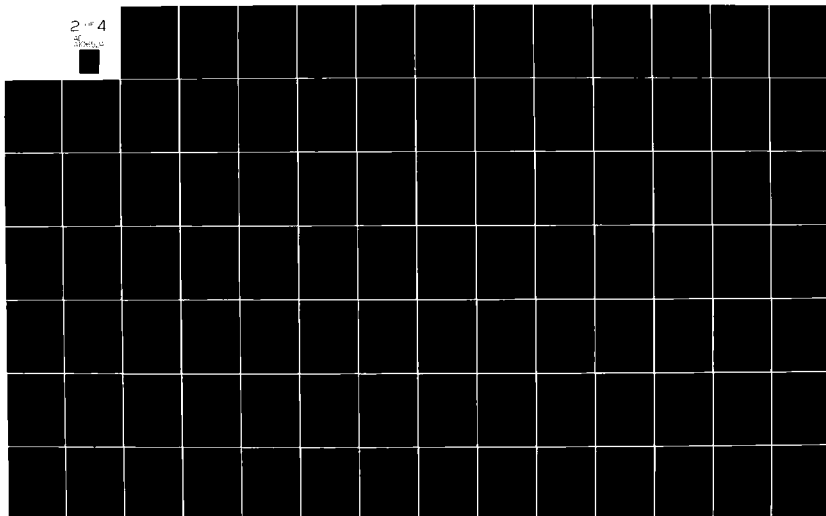
$$\Delta\{DEF/GNP^1\} = -.04863 + 0.64681 \ \Delta log_e\{GNP/P\} + 0.30740$$
$$(4.02) \qquad\qquad (9.54)$$

$$\Delta\{Govt/GNP^1\} + 0.13546 \ (NDef)/GNP^1 \qquad\qquad (58)$$
$$(5.35) \qquad\qquad (2.23)$$

Durbin-Watson statistic = 1.7414

First order autocorrelation coef. = 0.140

Standard error of auto. coef./random model = 0.171.

For the 32 observations and three independent variables, the appropriate values of the Durbin-Watson statistic are $d.w._1$ = 1.24 and $d.w._u$ = 1.65. Since the calculated value of the statistic was 1.74, the absence of both positive and negative serial correlation is indicated.

Figure 5 is a plot of the standardized residual values from this regression model. Figure 6 is a coincident plot of the actual values of the changes in defense spending deflated by GNP and the calculated values of this same variable.

Solving the least squares regression equation for changes in output (equation 56) to derive an expression for changes in defense spending (equation 57) introduces several statistical problems. The most significant of these problems is that the resulting expression (equation 57) is not a least squares estimate of the changes in defense spending. The parameters of the model were selected to minimize the squared deviations of the estimated values of the change in output and the actual values of that variable. Such a procedure does not minimize the squared deviations of the actual and calculated values of one of the independent variables included in the model. The least squares

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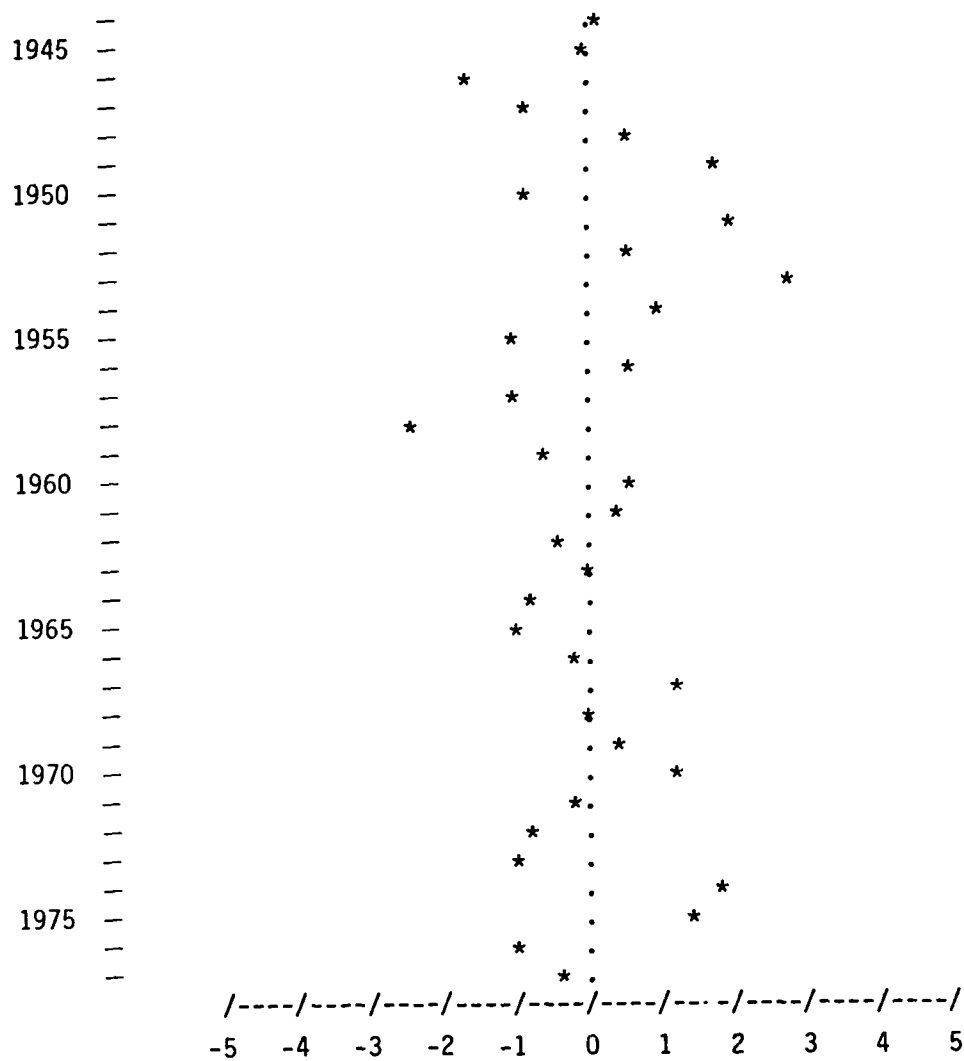
FIGURE 5

Plot of Standardized Residuals

(U.S. Defense 1944--1977)

Scaled by 10**3

```
        -300    -250    -200    -150    -100    -50      0      50     100
        /-------/-------/-------/-------/-------/-------/-------/-------/
1944
1945
1946
1947
1948
1949
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1970
1971
1972
1973
1974
1975
1976
1977
        /-------/-------/-------/-------/-------/-------/-------/-------/
        -300    -250    -200    -150    -100    -50      0      50     100
```

Name	Symbol	Mean Value
DELD/G	*	-1.07443E-02
FITTED	+	-1.07443E-02
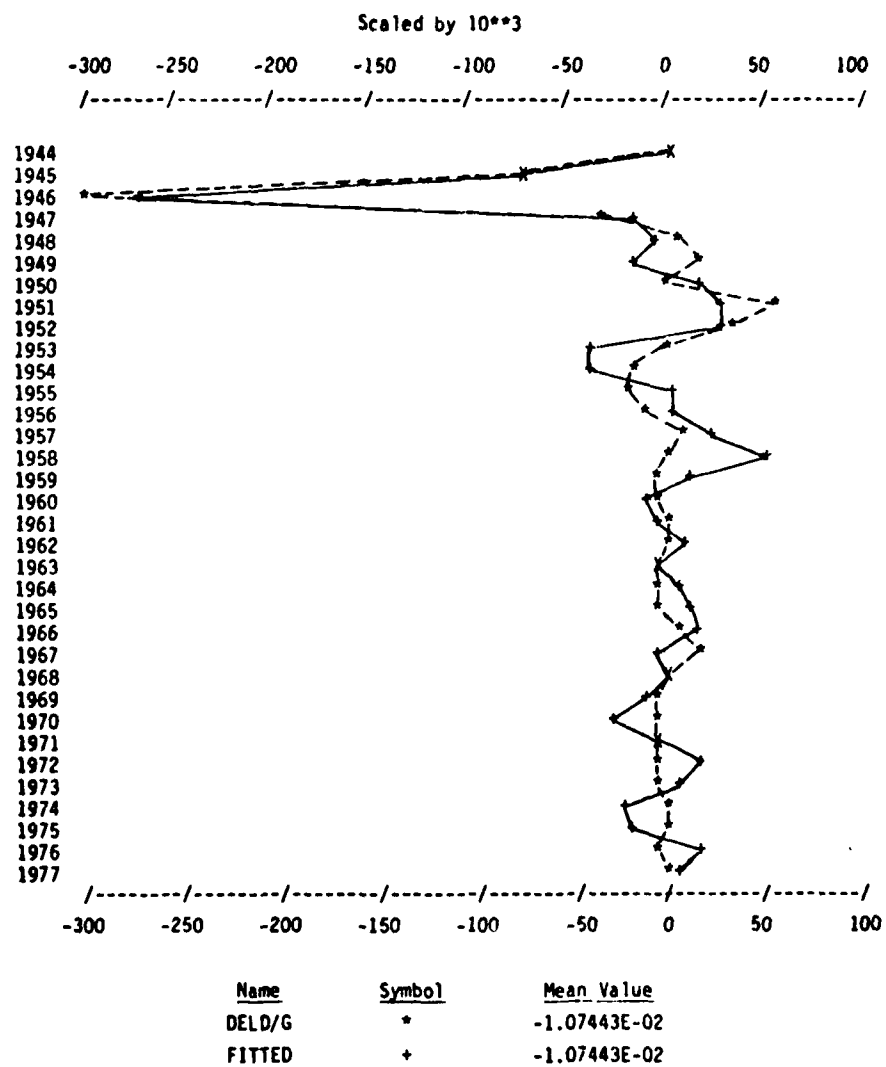
FIGURE 6

Actual versus Fitted Values

(U.S. Defense 1944--1977)

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estimate of the changes in defense spending is provided by Equation (58) which covers the same time period (1944-1977).

Alternative U.S. Defense Model

Equation 57 was developed using data series from the period 1944-1977. A cross-validation test of model's *ex post*[1] forecasting ability was not performed since no satisfactory alternative U.S. time period was available. However, as a test of the stability of the regression coefficients, the regression was performed for the consecutive periods of 1944-1959 and 1960-1977. The same three independent variables which were significant in the overall period was tested in each subperiod. The results indicated that the coefficients are temporally unstable.

Because of this instability, the last regression model form was that resulting from the analysis of the 1960-1977 period. The numerical estimates of Soviet defense spending in the 1965-1975 time frame is of primary interest in this study, so this U.S. model should capture any joint temporal relationships between the United States and the Soviet Union. The differences between the model developed using the overall time period and that using only the last seventeen years are apparent by examining the coefficients. Figures 7 and 8 show the plots of standardized residuals and actual versus fitted, respectively. The alternative equation is

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[1]*Ex post* forecasting in the sense that concurrent values of the independent variables are used for the "prediction." Alternatively, This could be referred to as "backcasting."

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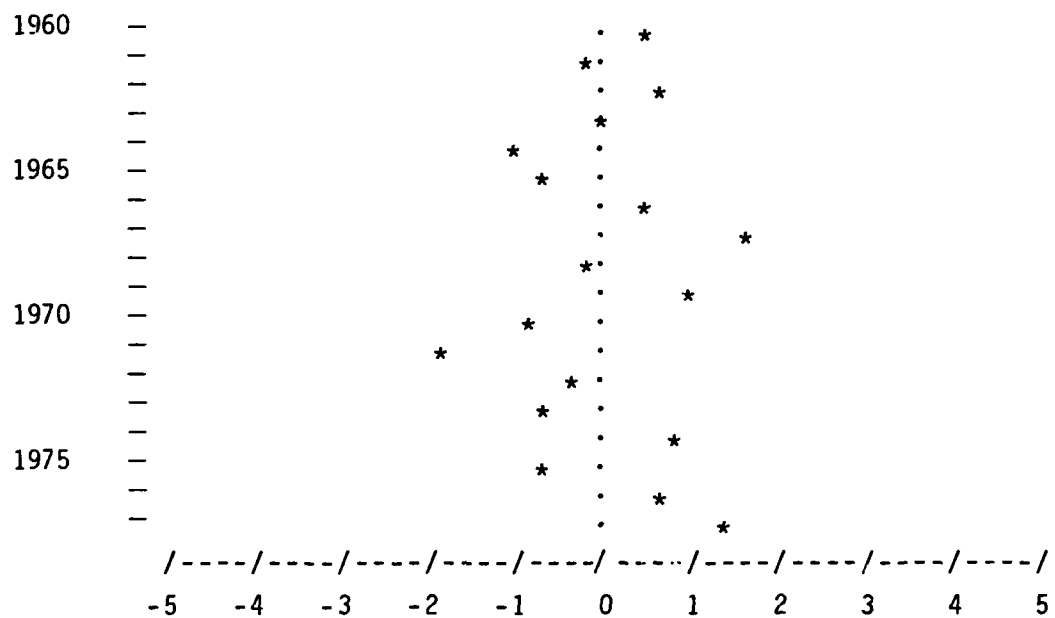
FIGURE 7

Plot of Standardized Residuals

(U.S. Defense 1960--1977)

Scaled by 10**4

Name	Symbol	Mean Value
FITTED	*	-2.43595E-03
DELD/G	+	-2.43595e-03
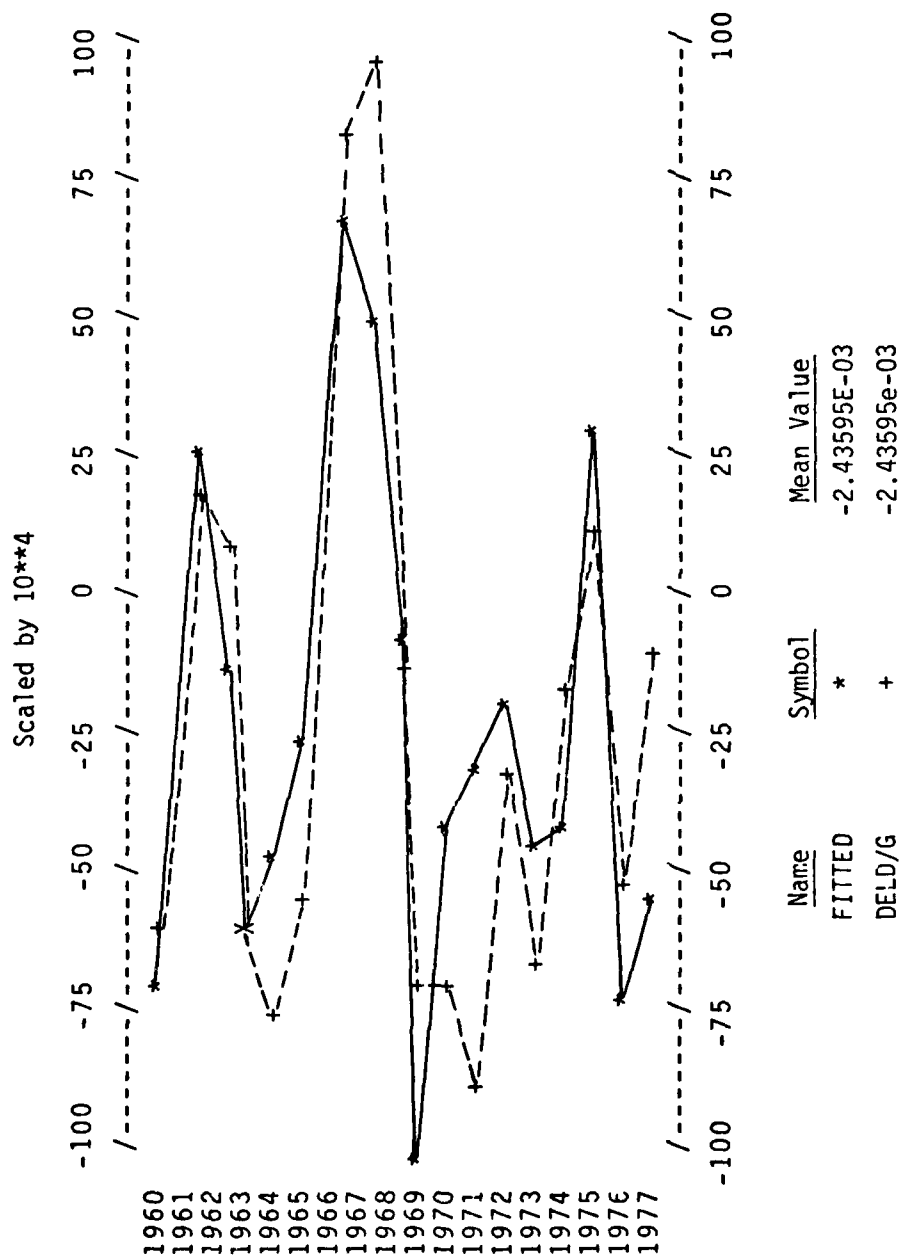
FIGURE 8

Actual versus Fitted Values (U.S. Defense 1960--1977)

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$$\Delta\{Def/GNP^1\} = -0.01769 + 0.61570\ \Delta\{Govt/GNP^1\} + 0.20643$$
$$\phantom{\Delta\{Def/GNP^1\} = -0.01769 +}(2.66)(5.84)$$

$$\Delta\log_e(GNP/P) + 0.039084\ (NDef)/GNP^1 \qquad\qquad (59)$$

F statistic for the overall equation = 11.67

Durbin-Watson statistic = 1.620   Mult. R = 0.8452

First order autocorrelation coef. = 0.114

Standard error of auto. coef./random model = 0.236

$d.w._1 = 1.00$ $d.w._u = 1.68.$

The coefficient of the nondefense spending variable, it should be noted, is not significant at the 0.05 level.

Examining the coefficients of the independent variables shows that changes in defense spending are more sensitive to changes in total government spending in the 1960-1977 period compared to the overall period. They are, however, less sensitive to changes in nondefense spending and percentage changes in total output.

The correlation matrices of the tested variables are presented in Tables 3 and 4.

The Soviet Data

The form of the regression equations was strongly influenced by the perceived availability and accuracy of equivalent Soviet data. Again, the explicit contention is that the economic behavior of the Soviet Union to changes in defense and nondefense spending is sufficiently close to that of the United States to allow the use of the U.S. model.

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TABLE 3

CORRELATION MATRIX
(U.S. Data 1944 - 1977)

	DLNG/P	WED/G	DELW/G	DEXM/G	DEF/G	GEXM/G	DELD/G
DLNG/P	1.000						
WED/G	0.057	1.000					
DELW/G	0.428	0.044	1.000				
DEXM/G	-0.880	0.048	-0.190	1.000			
DEF/G	0.046	0.714	-0.027	0.036	1.000		
GEXM/G	-0.002	0.101	0.087	0.015	-0.625	1.000	
DELD/G	0.849	0.093	0.691	-0.673	-0.052	-0.178	1.000

TABLE 4

CORRELATION MATRIX
(U.S. Data 1960 - 1977)

	DLNG/P	WED/G	DELW/G	DEXM/G	DEF/G	GEXM/G	DELD/G
DLNG/P	1.000						
WED/G	-0.5C4	1.000					
DELW/G	-0.707	0.174	1.000				
DEXM/G	-0.863	0.236	0.888	1.000			
DEF/G	0.148	-0.724	0.237	0.127	1.000		
GEXM/G	-0.391	0.957	0.012	0.098	-0.893	1.000	
DELD/G	-0.034	0.003	0.600	0.168	0.257	-0.105	1.000

Definition of Variables:

DLNG/P = Delta Logarithm of real GNP/working age population

WED/G   = Total government budget (wedge)/current GNP

DELW/G = First differences of WED/G

DEXM/G = First difference of GEXM/G

DEF/G   = Total defense expenditures/current GNP

GEXM/G = (total nonproduction government expenditures minus
          defense spending) deflated by current GNP

DELD/G = First differences of DEF/G

Theoretically, the factor cost GNP series, both constant and current price, would be most correct for inclusion into our model. Unfortunately, such series are difficult to obtain. The Central Intelligence Agency has published a constant price GNP series (both in established prices and factor cost) which could be used in our model. There is not, however, an equivalent current price GNP series produced by the CIA.

Any current or constant price GNP series that is calculated from Soviet data must be considered a hybrid. Not all Soviet prices change in response to changing preferences and changing costs of production. Goods that undergo some technological change are often repriced to reflect more closely their opportunity cost. Other goods may only be repriced as part of a major price reform. The composition of the established price and the factor cost GNP series, as well as their method of computation are discussed in Appendix D, Soviet Statistics. Also included is a discussion of the differences between the real and the current series.

Two independently derived current price GNP series were made available for this study. The first, and the most extensive, was provided by Lee (1978) and is based on the sector of origin and is in the sector of origin and is in established prices. The second data series was computed by G.E. TEMPO from the constant price GNP series released by the CIA. It too was by sector of origin. A partial series covering the period 1970-1975 was prepared by the British. This series was by sector of origin and was in established prices. Since the

British data did not cover the entire period of interest, it was not used to calculate a formal alternative estimate. Instead, partial estimates for the 1970-1975 period were computed as an additional check on the sensitivity of the model to different GNP series.

The two current price GNP series were used in several alternative calculations to deflate the defense and nondefense spending variables. Another alternative estimate was calculated by deflating these variables by the constant factor cost series of the CIA. The theoretical biases this procedure may introduce into the results may be somewhat minimized in actual application if the Soviet price level was relatively constant. The Soviet Union does not, generally, recognize inflation as an element of its economy. Indeed, many of the published Soviet indices show constant or declining prices. Independent estimates of the Soviet rate of inflation range from two to five percent *per annum*. Obviously, the lower the rate, the more reasonable the practice of ignoring the differences between current and constant GNP series.

Soviet working age population was taken as males between the ages of 16 and 59 and females between ages 16 and 54. This differs slightly from the 20-64 age group used to deflate U.S. constant GNP. The results do not change in any significant manner by the use of the slightly different age groups. Soviet population figures were taken from a study by Murray Feshback (1976).

The Soviet state budget was the basic source for current total government spending. The budget figure was not, however, used directly.

The Soviets finance certain productive activities from their budget. In a crude attempt to purge the series of these productive expenditures, the total for "Financing the National Economy" (FNE) less the FNE residual was subtracted from the budget total. This gave our measure of total government spending, which should be analogous to that of the U.S.

Appendix E on the Soviet state budget presented some arguments as to whether elements of defense spending are hidden in the budget residual and the FNE residual. Since there is strong evidence that such *could* by the case, these residuals were excluded in the calculations of nondefense spending. Also not included were the published "Defense" item from the budget and 25 percent of science expenditures. The latter is consistent with both the CIA and the Lee estimates of the proportions of defense research and development expenditures included in the "Science" allocation.

The Model Results

Table 5 presents the results obtained using the best form (based on the 1960-1977 period) model for changes in defense spending. Included in this table are the TEMPO reconstructed direct costing results and the independent estimate of Lee. The TEMPO/CIA estimates were derived by taking a baseline estimate of 42.5 billion rubles for 1970 (midpoint of the CIA's 40-45 ruble range) and extrapolating forward and backward using a 6.5 percent growth factor. The growth factor combined the CIA estimated growth in real defense expenditures (4.5

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TABLE 5

ALTERNATIVE ESTIMATES – SOVIET DEFENSE EXPENDITURES
(Billion Rubles)

Year	CIA[a]	Lee[a]	Alt_1	Alt_2	Alt_3	Alt_4
1966	33.0	28.3	28.4 (+ 1.3)	22.6 (+ 2.0)	30.3 (+ 0.9)	29.5 (+ 1.2)
1967	35.2	32.3	30.4 (+ 2.4)	26.5 (+ 2.8)	31.0 (+ 1.7)	31.2 (+ 2.2)
1968	37.5	38.3	36.1 (+ 2.0)	33.9 (+ 2.8)	37.2 (+ 1.3)	36.9 (+ 1.5)
1969	39.9	41.8	39.4 (+ 2.8)	37.9 (+ 3.0)	39.9 (+ 2.1)	39.5 (+ 2.7)
1970	42.5	45.8	45.8b	45.8b	45.8b	45.8b
1971	45.3	50.0	49.3 (+ 2.3)	49.5 (+ 1.9)	48.6 (+ 1.6)	48.7 (+ 1.9)
1972	48.2	54.8	51.2 (+ 2.3)	53.9 (+ 2.1)	48.8 (+ 3.2)	50.1 (+ 1.9)
1973	51.4	60.5	56.2 (+ 3.0)	58.2 (+ 2.2)	53.2 (+ 2.4)	54.8 (+ 2.8)
1974	54.7	65.0	61.3 (+ 3.2)	64.0 (+ 2.5)	59.1 (+ 2.5)	59.2 (+ 2.6)
1975	58.2	71.3	64.3 (+ 3.1)	69.5 (+ 2.9)	59.3 (+ 2.0)	61.0 (+ 2.7)
Overall g^c	6.50	10.45(+ 0.17)	9.74 (+ 0.26)	12.97 (+ 0.35)	8.21 (+ 0.34)	8.71 (+ 0.27)
66-70 g	6.50	12.98(+ 0.51)	12.92(+ 0.47)	19.42 (+ 0.42)	11.39 (+ 0.74)	11.30 (+ 0.56)
70-75 g	6.50	9.26(+ 0.08)	7.23 (+ 0.27)	8.74 (+ 0.07)	5.77 (+ 0.65)	6.20 (+ 0.27)

[a] SOURCE: McMeekin, Gordon C. Alternative Baseline Estimates of Soviet National Security Expenditures. (Internal working paper). G. E. Tempo Center for Advanced Studies, 1978.

[b] Baseline for alternative estimates.

[c] Growth rates are annualized from a continuously compounded curve fit.

TABLE 5 - continued

Alt_1 - GNP at constant factor cost (CIA data) is used for GNP and GNP[1].

Alt_2 - GNP in current established prices (Lee data) is used for GNP and GNP[1].

Alt_3 - GNP at constant established prices (CIA data) is used for GNP, GNP in current established prices (Lee data) is used for GNP[1].

Alt_4 - GNP at constant factor cost (CIA data) is used for GNP, GNP at current factor cost (Tempo data) is used for GNP[1].

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percent *per annum*) and a conservative estimate of Soviet inflation (2 percent *per annum*). The reconstructed CIA series in Table 5 are included strictly to show the implied values given by the Agency's estimated growth rate. The CIA has not published revised estimates for Soviet defense expenditures for the 1966-1975 period.

Three growth rates were calculated for each spending series. One covers the entire ten year period; the other two cover five year subperiods. This breakdown serves as a check on the CIA contention that the growth in Soviet defense expenditures has remained relatively constant over the ten year period.

Earlier it was acknowledged that the proposed new methodology is subject to stochastic variations which could result in significant error residuals in any given year. Averaged over a five to ten year period, these fluctuations should only have a moderate effect on the growth rate estimates. To minimize these random effects, the series were fitted to an exponential growth curve of the form

$$\text{Defense} = a \; e^{bt} \quad (e \approx 2.718)$$

where a is a fitted constant and b is the fitted continuous growth rate. This rate was annualized by solving for

$$r = e^{b} - 1$$

where r is the annualized growth rate.

The alternative estimates need further explanation. The model gives only an estimate of changes in defense spending, deflated by GNP. To obtain levels some base estimate of defense spending must be selected.

For the alternative series, 1970 was selected as the base year with a
base estimate of 45.8 billion rubles. This estimate was somewhat
arbitrarily selected. It is equal to the Lee estimate for 1970 and just
slightly above the CIA range estimate of 40-45 billion rubles. This
eases the comparison with the Lee estimates and, additionally, is
equivalent to the CIA estimate plus the opportunity cost of Soviet
conscripts. The model was designed to capture the real cost of defense
spending, not just what might result from a nonmarket accounting
system. (This is true to the extent that the U.S. analogue represents
true market prices.) Since portions of these hidden costs will not be
picked up by the existing estimation methodologies, they are explicitly
recognized by using the higher base estimate. The levels of the
alternative series are somewhat arbitrary because of the method used
to select the base year expenditure level. The growth rates, however,
do not suffer from this limitation.

Alternative Estimates

The Alt_4 estimates of Soviet defense spending (based on the
CIA and TEMPO factor cost GNP series) are the "best estimates" based on
the alternative model. This model was also exercised using other GNP
series.

Earlier tests indicated that the coefficients of the model were
not stable over time. As a result, it was expected, *a priori*, that the
model for defense spending developed over the 1960-1977 period would be
the most accurate for our purposes. This was the model used to produce

the results shown in Table 5 and graphically depicted in Figure 9.

Using the constant GNP series instead of the more theoretically correct current series to deflate defense and nondefense spending should overestimate the growth rate in the years prior to the base year and underestimate it in the following years. This would correspond to the Alt_1 estimate in Table 5, which was based on the CIA 1970 constant factor cost GNP series. This estimate reflects a much higher growth rate in defense expenditures (12.9 percent versus 7.4 percent) in the 1966-1970 period than in the 1971-1975 time frame. At least part of this differency may be due to the use of the constant GNP series.

An opposite effect should result from using only a current GNP series in the model. The Alt_2 estimates were based on such a series (that of Lee). The differential growth rates between the two periods are still present in these estimates. An even higher rate would have been estimated in the earlier period (and a correspondingly lower rate in the later period) if a constant price Lee series were used in the model. Such a series is currently unavailable.

The Alt_3 estimates combined the CIA constant established price GNP series and the Lee current established price series. The model based on these data still estimated a significantly higher growth rate in defense spending in the 1966-1970 period than in the 1971-1975 period.

The "best estimate" Alt_4 results are very close to those of Alt_3. The growth rates in each subperiod are only a fraction of a percentage point higher.
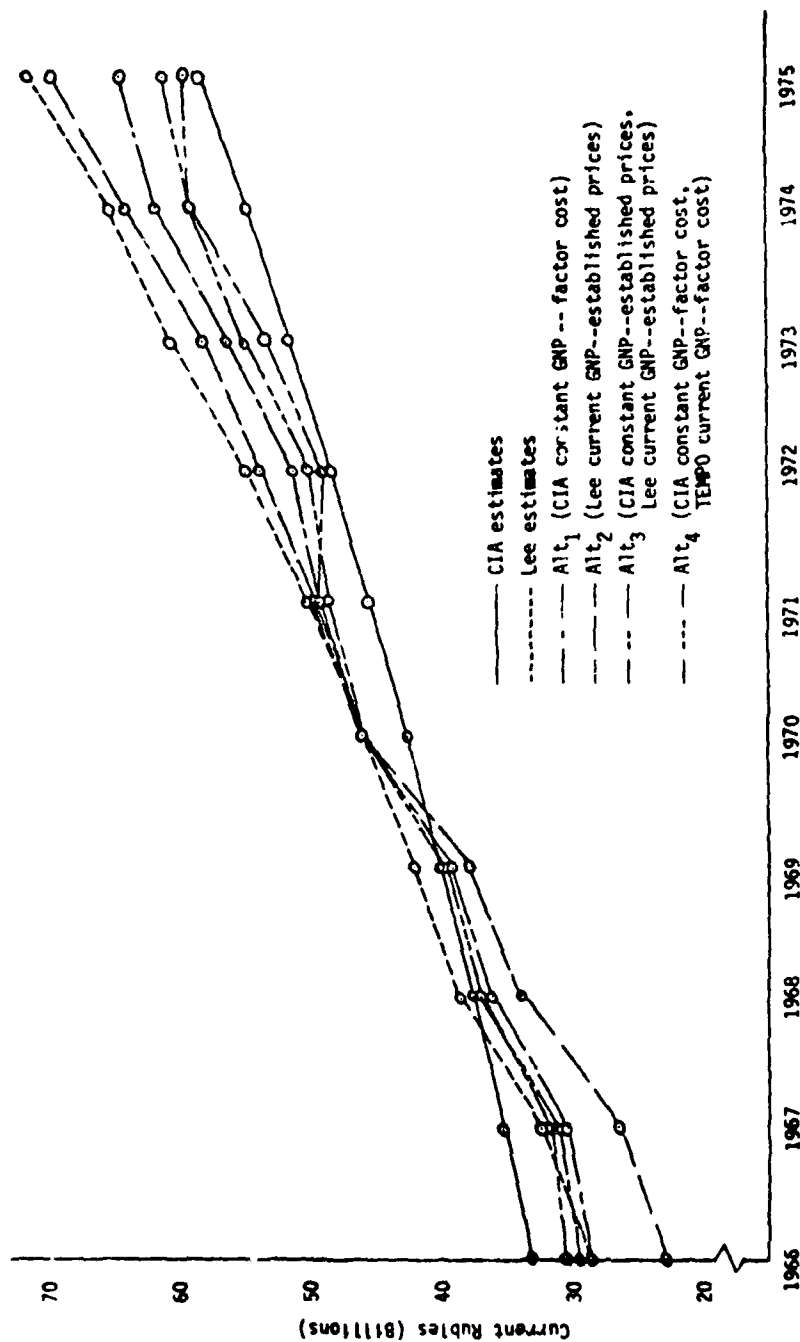
FIGURE 9

Alternative Estimates--Soviet Defense Expenditures

Legend:
— CIA estimates
--- Lee estimates
—·— Alt$_1$ (CIA constant GNP--factor cost)
—— Alt$_2$ (Lee current GNP--established prices)
—··— Alt$_3$ (CIA constant GNP--established prices.
        Lee current GNP--established prices)
—···— Alt$_4$ (CIA constant GNP--factor cost,
        TEMPO current GNP--factor cost)

Y-axis: Current Rubles (Billions) — 70, 60, 50, 40, 30, 20

X-axis: 1966, 1967, 1968, 1969, 1970, 1971, 1972, 1973, 1974, 1975

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The Lee current price GNP series for the period 1970-1975 reflect a slightly higher output growth rate than does the current price British series for the same period. The model was exercised using the CIA constant established price GNP series along with the British series. As expected, the results were quite similar to that obtained when the Lee data were used in conjunction with that of the CIA.

The results (in billions of current rubles) using the British series and a base estimate of 45.8 in 1970 are

1970	45.8
1971	48.6
1972	49.3
1973	52.5
1974	58.6
1975	59.3

and the annualized trended growth rate is 5.63 percent.

Despite discrepancies in the results due to the different GNP series used in the calculations, certain preliminary conclusions can still be drawn.

All four estimates show a sharp increase in Soviet defense expenditures in the 1966-1970 period. The growth rate slows in the early 1970s. The rate over the entire ten year period ranges from slightly higher to significantly higher than predicted by the revised CIA estimates, and generally just slightly lower than estimated by Lee.

Again, it should be emphasized that the regression model was developed to show the empirical relationship between various forms of government spending and output changes. Biases may be introduced into the model when applying the relationships to the Soviet Union.

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Obviously, the major potential bias source is related to the assumption that the economic behaviors of the U.S. and the Soviet Union are similar. Additionally, biases may be introduced when modifying Soviet data to match their U.S. equivalents.

The various estimates do strongly suggest that the growth rate of Soviet defense spending in the latter half of the 1960s was significantly greater than that in the earlier 1970s. Both rates are, however, significantly higher than the growth of U.S. defense expenditures (in real terms).

The slowing of the growth rate in Soviet defense expenditures is supported on economic grounds. For possible reasons for this, see the works of Calmfors and Rylander (1976), Bergendorff and Strangert (1976), and the CIA (1977b).

Earlier Model Forms

The use of the U.S. defense model (equation 59) produced what appears to be reasonable results (Table 5). As expected, the results using the rearranged U.S. output model (equation 57) and the overall U.S. defense model (equation 58) were not as reasonable.

Table 6 lists the results using the latter two models based on both the CIA constant factor cost GNP series and the CIA/Lee series in constant and current prices, respectively. Both models appear to over-predict the growth rate in Soviet defense expenditures. Using the U.S. output model (equation 57) does not provide least squares estimates of defense spending. Such estimates are provided by the defense model (equation 58).

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TABLE 6

ALTERNATIVE ESTIMATES - SOVIET DEFENSE EXPENDITURES
(Billion Rubles)

| Year | U.S. Defense Model 1944-1977 | | U.S. GNP Model 1944-1977 | |
	Alt_5	Alt_6	Alt_7	Alt_8
1966	13.6	13.5	-55.6	6.2
1967	18.1	18.4	-17.9	10.6
1968	27.1	27.5	4.2	21.9
1969	31.2	31.1	11.6	20.2
1970	45.8^a	45.8^a	45.8^a	45.8^a
1971	52.7	51.9	47.4	42.6
1972	54.5	51.1	42.0	9.5
1973	70.1	65.7	55.7	26.2
1974	79.2	79.9	62.6	42.3
1975	83.7	81.7	91.2	36.9
Overall $\bar{g}$	22.3%	21.8%		
66-70 $\bar{g}$	34.6	34.6		
71-75 $\bar{g}$	13.9	14.5		

Alt_5 and Alt_7 - GNP @ 1970 constant factor cost - CIA

Alt_6 and Alt_8 - GNP @ 1970 constant established prices - CIA, GNP @ current established prices - Lee

[a]Estimate base.

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It is felt, however, that the long time period used to calculate the coefficients of the model confound the results. If the model, as claimed, captures the economic behavioral responses, it is reasonable to assume that such responses change when world conditions and other exogenous variables change. This is reflected in changing values for the coefficients of the independent variables. A model based on a shorter time period (such as equation 59) in which exogenous factor changes between the U.S. and the Soviet Union are minimized should produce the most accurate results.

Again, the tentative nature of the results should be emphasized. The structure of the model is simple, and the choice of variables somewhat arbitrary. Final tests of the results must await the release of the actual series of Soviet defense spending.

Confidence Interval Estimates

It is possible, within the constraints of the model's assumptions, to provide confidence intervals for our estimates. Such estimates for the Alt (1-4) results are included in Table 5.

Statistically, confidence limits for the true mean value of the dependent variable, given values of the independent variables are given by

$$\hat{y} \pm t\{(n-p-1),\ 1-\tfrac{1}{2}\alpha\}s_e\{X_0'(X'X)^{-1}X_0\}^{\frac{1}{2}}$$

where

$\hat{y}$ is the point estimate, given the values of the independent variables.

X_0 is the vector of independent variables used to calculate Y

X is the matrix of independent variables used to calculate the regression equation.

t is the τ statistic with $n-p-1$ degress of freedom (n=number of observations, p=number of parameters estimated, α is the level of significance).

Primes denote the transpose of the matrix, a (-1) exponent denotes the inverse of the matrix.

The confidence intervals for growth rates pertain solely to the estimation technique used to calculate the growth parameter. The intervals actually pertain to the continuously compounded growth rates, not the annualized rates reported in Table 5. The differences, however, are not significant. In addition to growth rate intervals for the Alt (1-4) results, the intervals for the Lee and CIA estimates are also included. This provides a common basis for juxtaposing the alternative estimates.

In fitting the exponential curve to the defense expenditure data, $\hat{y} = ae^{bx}$ the form was first linearized to

$$\log_e \hat{y} = \log_e a + bx$$

where, again, b represents the constant gorwth rate parameter.

The percentage rate for the standard error of the estimate was calculated from the relationship

$$\sigma_e = 100(1-r^2)^{\frac{1}{2}}(\{\Sigma(\log_e\hat{y}^2) - (\Sigma\log_e\hat{y})^2/N\}/(N-1))^{\frac{1}{2}}$$

where

r^2 is the coefficient of determination

N is the number of observations.

The confidence interval estimate for the slope parameter, b, is then given by

$$b \pm \frac{t_{(-2, \ 1-\frac{1}{2}\alpha)}\sigma_e}{\{\Sigma(x_i - \overline{x})^2\}^{\frac{1}{2}}}$$

In all cases a 0.95 confidence was used to calculate the interval estimates.

Since the CIA estimates were constructed by applying a constant 6.5 percent rate of growth of defense expenditures, there is no variation in their rates.

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CHAPTER VI

THE THEORY AND APPLICATION OF INDEX NUMBERS

Index number theory provides methods for comparing dissimilar items (normally quantities or prices). The specific form taken by an index is somewhat arbitrary, depending on the rules used for aggregating and weighting the data. For our purposes we will consider indices which provide intertemporal or cross-country comparisons of prices or quantities.

Regardless of whether one forms price or quantity indices, one must consider the concept of price. Price can only be defined in terms of exchange. Price then is always a relative concept: it is the conversion factor between two quantities, the ratio of exchange. In a two-product case (product A and B) two possible price bases exist. If A is the base then the sole non-unity price is the number of units of B that exchanges for one unit of A. Similarly, if B is the base, the sole non-unity price is the number of units of A that exchanges for one unit of B. In an (n) product case, there then exist (n-1) unique prices for each base.

The index number problem which confounds the comparison between the levels of U.S. and Soviet defense expenditures is rooted in the choice of a price base. This base can be either in terms of the relative prices of the vector of Soviet goods or in terms of the relative

prices of the vector of U.S. goods. The necessary choice is between using U.S. or Soviet price relatives and the proper base for that relative.

As an example, consider a simple two defense good case where the U.S. produces five units of conventional armament (C), ten units of advanced armament (A), and is willing to trade off two units of A for each unit of C. The Soviets produce eight units of C and eight of A and are willing to trade off one unit of C for each unit of A. If the conventional armament good is chosen as the base, the expenditures in the U.S. would be

$$5 C + 2 C/A (10A) = 25 C.$$

Expenditures in the Soviet Union would be

$$8 C + 1 C/A (8 A) = 16 C.$$

If the advanced armament good is chosen as the base, the total expenditure in the U.S. would be

$$1/2/ A/C (5 C) + 10 A = 12 1/2 A.$$

Similarly, expenditures in the Soviet Union would be

$$1 A/C (8 C) + 8 A = 16 A.$$

In this example, expenditures in the U.S. exceeded that in the Soviet Union by 56.25 percent if conventional armament is the base. However, when advanced armament is selected as the base, expenditures in the Soviet Union exceeded that in the U.S. by 28 percent. This example illustrates how it is possible under certain price relatives and quantity mixes for expenditures in the U.S. to exceed that in the

Soviet Union in one base, and for Soviet expenditures to exceed that of the U.S. in another base. This is one of the index number problems which will be discussed in more detail later in this chapter.

For expositional simplicity, a vector format for depicting a value (or expenditure) variable shall be used. For example, when forming indices for comparing values in two different time periods, we define a value aggregate variable as

$$V_{ik} = p_{i1}x_{k1} + p_{i2}x_{k2} + \cdots + p_{in}x_{kn} \tag{60}$$

$$= \sum_{j=1}^{n} p_{ij}x_{kj} = \sum_{j} p_{ij}x_{kj} = P_i X_k \tag{61}$$

where

p_{ij} = price of good j in time period i

x_{kj} = quantity of good j in time period k

P_{ij} = 1 when good j is the price base

= relative price between good j and the price base, otherwise

V_{ik} = total value of the n goods in time period k weighted by prices in period 1.

In the case where $i=k$, V_{ik} = total actual expenditures that period.

In the case where the same time period is used for the price weights and for the quantities in the expression for the value variable, a value index can be formed which follows the relationship

$$V_{ik} = \sum_{j} p_{ij}x_{ij} / \sum_{j} p_{kj}x_{kj} . \tag{62}$$

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This expression is simply the ratio of actual expenditures in two different time periods, period (i) and period (k).

While such an index measures changes in value, it tells nothing about why total expenditures differ between periods. It gives no information about changes in individual quantities or prices.

Quantity (or price) indices of the form desctibed below offer a means of comparing quantity (or price) changes in terms of common weights. The resulting indices then can be used as a measure of relative quantity (or price) changes.

Crowe (1965) lists three general rules for weighting, which are consistent with the standard index forms.

1. Price aggregated should be weighted by quantities.

2. Price ratios and quantity ratios should be weighted by values.

3. Quantity aggregates should use prices as weights.

Such weighting schemes are used in the following quantity indices:

$$X_{01}^{P} = \frac{\sum_{i} s_{1i} p_{1i}}{\sum_{i} x_{0i} p_{1i}} \qquad \text{Paasche quantity index} \qquad (63)$$

$$X_{01}^{L} = \frac{\sum_{i} x_{1i} p_{0i}}{\sum_{i} x_{0i} p_{0i}} \qquad \text{Laspeyres quantity index.} \qquad (64)$$

These indices give a relative comparison between quantities using base or final year price weights.

Similarly, a price index can be formed.

$$P_{01}^P = \frac{\sum_i x_{1i} p_{1i}}{\sum_i x_{1i} p_{1i}} \qquad \text{Paasche price index} \qquad (65)$$

or

$$P_{01}^L = \frac{\sum_i x_{0i} p_{1i}}{\sum_i x_{0i} p_{0i}} \qquad \text{Laspeyres price index.} \qquad (66)$$

These indices compare different year prices using common base or final year quantity weights.

Instead of forming intertemporal indices, spatial comparisons can be made. Such will be the form used in our general comparison of the level of defense expenditures in the United States and the Soviet Union.

Forming quantity indices requires the use of common price weights. If we use a Paasche quantity index, all quantites are weighted by final year prices. This index would generally be different than a Laspeyres quantity index, where all quantities are weighted by base year prices. The Paasche and Laspeyres quantity indices will be identical only for the case where the relative price weights are the same for the two periods. When such index forms are used for comparing U.S. and Soviet defense expenditures, the weights are considerably different. This problem has been previously illustrated in our conventional and advanced armament example.

Several other index formulae have been proposed to circumvent the discrepancies between Paasche and Laspeyres indices. One form, the Marshall-Edgeworth Index, presents a compromise between base and final

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year weights. It follows the relationship

$$X_{01} = \frac{\sum\limits_i x_{0i}(p_{0i} + p_{1i})}{\sum\limits_i x_{0i}(p_{0i} + p_{1i})} \; . \tag{67}$$

Irving Fisher (1967, p. 44) identified properties that an ideal index should possess. He concluded that such an index should pass the following six tests:

1. Identity test: $p_{ii} \equiv 1$.

2. Proportionality test: $P_{st} = k$ when $p_t = k(p_s)$, ($p_t =$ price in year t) i.e., when all prices move in proportion, so does the index.

3. Change of units test: P_{st} is invariant under any change in the money or physical units in which individual prices are measured.

4. Time reversal test: $P_{st} = 1/P_{ts}$ (s $\neq$ t, t = 0, 1, 2, ...).

5. Circularity test: $P_{os} \times P_{st} = P_{ot}$ (s $\neq$ t, t = 0, 1, 2, ...).

6. Factor reversal test: $P_{ik} \times X_{ik} = V_{ik}$, that is, the change in aggregate value from year (i) to year (k) should be the product of the price and the quantity indices.

Fisher's proposed ideal index is the only economically meaning-ful form which passes all except the circularity test. Fisher further showed that the time reversal and circularity tests are mutually exclusive. No index can pass both tests.

The Fisher's index is the geometric mean of a Paasche and the corresponding Laspeyres index

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$$I_F = (X_{01}^P \times X_{01}^L)^{1/2}$$

$$= \left(\frac{\sum_i x_{1i} p_{1i}}{\sum_i x_{0i} p_{1i}}\right) \times \left(\frac{\sum_i x_{1i} p_{0i}}{\sum_i x_{01} p_{0i}}\right)^{1/2} . \tag{68}$$

Diewart (1976) has shown that, under certain conditions, the Fisher index meets the criteria necessary to be considered an "exact" index. Such indices provide useful second order approximations to a general class of continuous functions.

These fundamental definitions and relationships will now be applied to the problem of intertemporal or cross-country comparisons.

U.S. — Soviet Comparisons

This section develops a simplified model of index number relationships, consistent with the current methodology for comparing U.S. and Soviet defense expenditures. This model will be used to explain certain characteristics of this comparison. In the next section such index relationships will be analyzed from a utility context.[1] It will be shown that, from a utility viewpoint, the results using the current methodology may be misleading.

A two product case is assumed where

x_1 = quantity of conventional armament

x_2 = quantity of advanced armament.

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[1] It can be argued that utility considerations provide a surrogate for the perceived differences in military capability, a potentially far more useful comparison.

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We further assume that x_1 is used as the basis for the price system (i.e., $p_1 = 1$). The price of x_2 (in terms of x_1) is p_2.

Under the current methodology, Soviet defense expenditures are considered unambiguously greater than U.S. defense expenditures if and only if (both conditions must be met)

$$x_1^s + p_2^s x_2^s > x_1^u + p_2^s x_2^u \qquad \text{(condition 1)} \qquad (69)$$

and

$$x_1^s + p_2^u x_2^s > x_1^u + p_2^u x_2^u \qquad \text{(condition 2)}. \qquad (70)$$

Condition 1 means that the quantities of Soviet armament weighted by the Soviet prices for each item exceeds the value of U.S. armament (determined by multiplying quantities of U.S. weapons by the Soviet prices for those weapons). The result is a Soviet based "real" price comparison, somewhat analogous to a ruble based comparison. Condition 2 states that the value of Soviet weapons (using Soviet quantities and U.S. prices) exceeds the value of U.S. armament (deter-mined by applying actual U.S. prices to U.S. weapons). This is the "real" price analog to dollar based comparisons.

The form of the conditions 1 and 2 relationships can be shown to be equivalent to a quantity index.

Taking condition 1, we have

$$\frac{x_1^s + p_2^s x_2^s}{x_1^u + p_2^s x_2^u} > 1 \qquad (71)$$

$$\frac{p^s x^s}{p^s x^u} > 1.$$

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Equation 71 is a form analogous to a Paasche quantity index with Soviet price weights.

Let

$$W_i = p_i^S x_i^S$$

then

$$\frac{P^S X^S}{P^S X^U} = \frac{\sum_i W_i}{\sum_i W_i (x_i^U / x_i^S)} > 1. \tag{72}$$

Earlier we listed three general rules for weighting developed by Crowe. The index relationship developed from condition 1 satisfies these rules. Quantity aggregates are indeed weighted by prices. Also, the quantity relatives (x^U / x^S) are weighted by values $(W = p^S x^S)$. Equation can be rewritten in the more standard form

$$I_1 = \frac{\sum_i W_i (x_i^U / x_i^S)}{\sum_i W_i} < 1 \qquad \text{(condition 1).} \tag{73}$$

That is, the arithmetic mean (weighted by actual Soviet defense expenditures) of the U.S./Soviet quantity relatives must be less than one.

Similarly, for condition 2

$$\frac{x_1^S + p_2^U x_2^S}{x_1^U + p_1^U x_2^U} = \frac{p^U x^S}{p^U x^U} > 1. \tag{74}$$

This is a form analogous to a Laspeyres quantity index with U.S. price weights.

Let

$$W_i' = p_i^U x_i^U$$

then

$$I_2 = \frac{p^u x^S}{p^u x^u} = \frac{\sum_i W_i'(x_i^S/x_i^u)}{\sum_i W_i'} > 1 \qquad \text{(condition 2)}. \qquad (75)$$

That is, the arithmetic mean (weighted by actual U.S. defense expenditures) of the Soviet/U.S. quantity relatives must be greater than one.

If conditions 1 and 2 both hold, then the graphical relationship depicted in Figure 10 is implied. Figure 11 depicts the case where condition 1 holds and condition 2 does not. Finally, if condition 2 holds and condition 1 does not, the graphical depiction in Figure 12 is implied.

The slopes of the budget constraints in Figures 10 - 11 are equal to the inverse of the price relatives between conventional and advanced armaments in the specified country ($1/p_2^S$ and $1/p_2^u$).
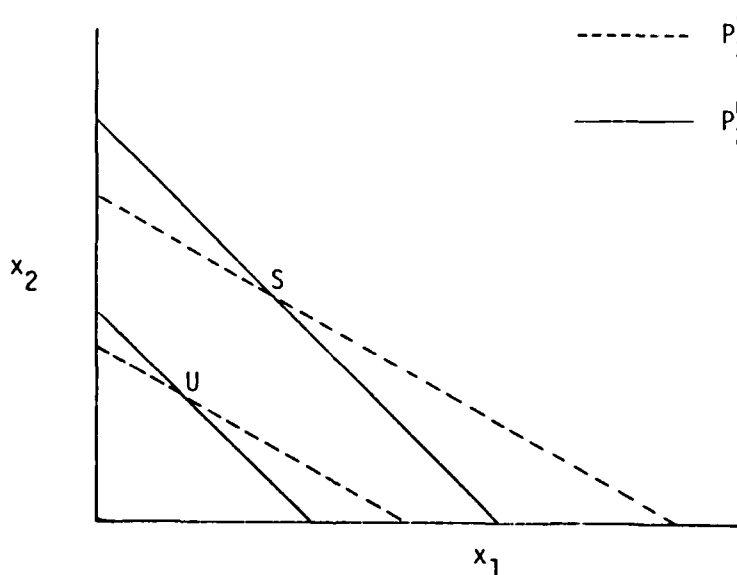
FIGURE 10

U.S. vs. S.U. PRICE RELATIVES (1)
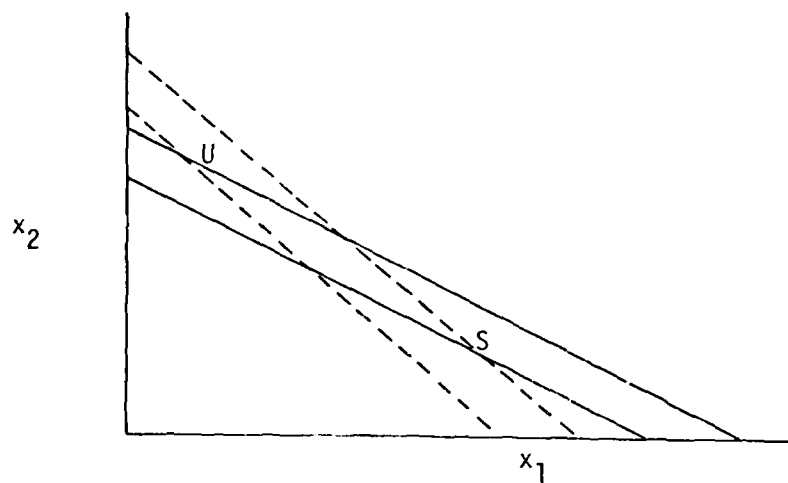
FIGURE 11

U.S. vs. S.U. PRICE RELATIVES (2)
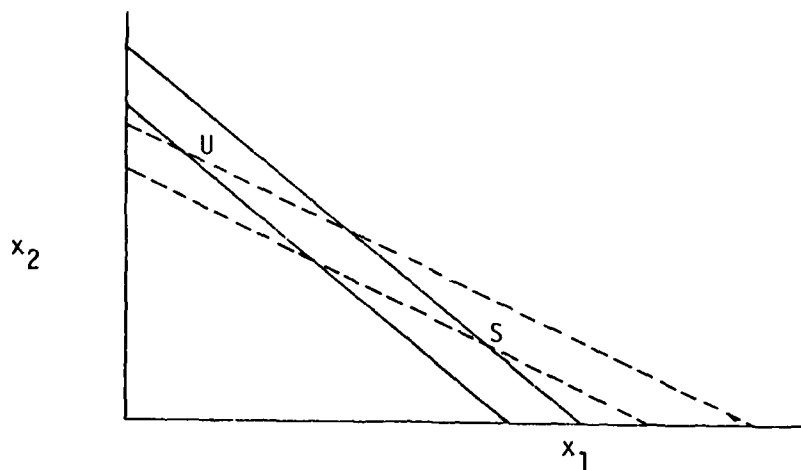
FIGURE 12

U.S. vs. S.U. PRICE RELATIVES (3)

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Utility Relationships

Utility theory can provide a better understanding of the impli-
cations of the different relationships depicted in Figures 10 - 12. A
cardinal utility function represents absolute levels of preference
attached to a set of goods. When only relative preferences can be
assigned, the utility function is ordinal. This latter form will be
used in our analysis.

The following characteristics of the nature of consumer pre-
ferences are implicit in the utility function considered in this
section: (Mansfield, 1975)

1. Consumer preferences are transitive. If the consumer
   prefers good set A to set B, and set B to set C, then
   he prefers set A to set C.

2. The consumer can always decide if he prefers the first
   set of goods to the second, the second to the first, or
   whether he is indifferent between them.

3. The consumer always prefers more of a commodity to less.

Characteristic 1 implies that indifference curves cannot inter-
sect. Characteristic 2 allows us to map the consumer's utility
function based on his stated preferences. Characteristic 3 leads to a
negative sloped indifference curve. Indifference curves which are
higher on the utility map represent greater levels of consumer satis-
faction than indifference curves which are lower. An assumption of
diminishing marginal rates of substitution results in coordinatewise
increasing convex indifference curves.

The following analysis follows Pareto utility theory in that it is *only necessary to know the consumer's indifference map* (in an ordinal sense) and not the cardinal utility function.

Pareto first showed that utility was maximized only at the point where the budget constraint was tangent to an indifference curve. At that point a precise relationship exists between marginal utility and marginal prices. (Hicks, 1978) In our two product case

$$P_2 = dx_1/dx_2$$

Utility, $U(x_1, x_2)$ is constant along an indifference curve, or

$$\partial U/\partial x_1 \, dx_1 + \partial U/\partial x_2 \, dx_2 = 0 \tag{76}$$

$$dx_1/dx_2 = P_2 = \frac{-\partial U/\partial x_2}{\partial U/\partial x_1}. \tag{77}$$

Hicks has analyzed the substitution effect of a change in relative prices. Such a change normally results in both an income and a substitution effect. By keeping the consumer on the same indifference curve after the price change that he was on before the change, the substitution effect can be isolated. This form of analysis is important in our case where the U.S. and the Soviet Union have different relative prices. When on applies U.S. prices to Soviet quantities and U.S. indifference curve, the new tangency solution is precisely related to the Hicks substitution effect analysis. The geometric relationships implied by this form of analysis will be used later to

show the "true"[2] index of U.S. and Soviet defense expenditures.

Whenever price relatives change such that the consumer, in equilibrium, remains on the same indifference curve, the value of the goods which would be purchased after the price change, evaluated at the prices in effect before the change must be greater than the value of goods previously purchased evaluated at the original price. (Hicks, 1968) The second vector of goods was not attainable under the budget constraint defined by the original set of prices. The tangency solution dictates that only one set of goods is attainable under that budget constraint, holding utility constant.

Under our original assumptions indifference curves are monotically decreasing and convex. The shape of such curves can also be used to show the above value relationships.
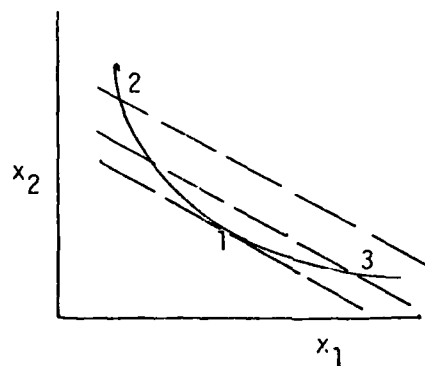
FIGURE 13

MINIMUM COST SOLUTION

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[2]The term "true" index is taken from the economics literature and is based on the concept of utility. "True" indices may be in - appropriate for many forms of comparison, such as the production considerations of the following chapter. Thus, the "true" index should not be taken as a universal ideal.

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If point 1 represents the original optimal combination of goods x_1 and x_2, and points 2 and 3 represent new optimal points for certain changes in relative prices, holding utility constant, value (budget) lines parallel to the point 1 tangency but passing through points 2 and 3, are always higher than the original value.

Mathematically, if

p, x = price and quantity before the change, respectively

p+dp, x+dx = price and quantity after the change, respectively,

then, from the previous analysis

$$\Sigma px \; < \; \Sigma p(x+dx). \tag{78}$$

Going from point 2 or 3 back to point 1 gives

$$\Sigma(p+dp)\,(x+dx) \; < \; \Sigma(p+dp)x. \tag{79}$$

Rearranging terms from Equations 78 and 79 yields the following quantity index relationships:

$$\frac{\Sigma(p+dp(x+dx)}{\Sigma(p+dp)x} \; < \; 1 \tag{80}$$

and

$$\frac{\Sigma p(x+dx)}{\Sigma px} \; > \; 1. \tag{81}$$

Equations 80 and 81 state mathematically that, along an indifference curve, an index of the relative equilibrium quantities of goods, weighted by the new prices, is always less than one. Such a ratio is always less than the relative quantity index weighted by the old prices. This latter index is always greater than one.

The problem of deriving the "true" index of relative defense expenditures, depicted graphically in Figure 14, is related to a methodology first proposed by Fisher and Shell (1972). The following example illustrates this technique in the context of the defense comparison.

Define $u(\cdot)$ as an ordinal utility function derived from a representative U.S. defense consumer preference map. Our problem is then to solve for the non-negative values of defense quantities, x_1, x_2, ..., x_n, that minimize

$$y = p_1 x_1 + p_2 x_2 + \ldots + p_n x_n \tag{82}$$

where p_i's are the U.S. price relatives, x_i ($i=1, 2, \ldots, n$) is the amount of the ith defense good that would be purchased at U.S. prices subject to

$$u(x_1, x_2, \ldots, x_n) \subset (\hat{x}_1, \hat{x}_2, \ldots, \hat{x}_n) \tag{83}$$

where $\hat{x}_i$ ($i=1, 2, \ldots, n$) is the amount of the ith defense good that is purchased by the Soviets faced with Soviet prices and defense budget level. The non-negative quantities of defense goods, $\hat{x}_1$, $\hat{x}_2$, ..., $\hat{x}_n$, are chosen to maximize Soviet utility, $u'(\hat{x}_1, \hat{x}_2, \ldots, \hat{x}_n)$, subject to the Soviet budget constraint

$$\hat{y} = \hat{p}_1 \hat{x}_1 + \hat{p}_2 \hat{x}_2 + \ldots + \hat{p}_n \hat{x}_n \quad (\hat{p}_i = \text{Soviet price relatives}).$$

Under the conditions of this analysis, the U.S. defense consumer would be indifferent to facing Soviet prices with a defense budget of $(\hat{y})$ or U.S. prices with a budget of (y). For a two good case,

Figure 14 depicts the general relationships. When comparing U.S. and
Soviet defense expenditures in terms of the U.S. preference structure
and price relatives, the level of spending defined by the value of (y)
and the related quantities $(x_1, x_2, \ldots, x_n)$ are the "true" dollar
values of the defense aggregate and quantities, respectively. The
analysis would follow the same form when deriving the "true" ruble
value of U.S. defense spending using Soviet price relatives and pre-
ference structure.
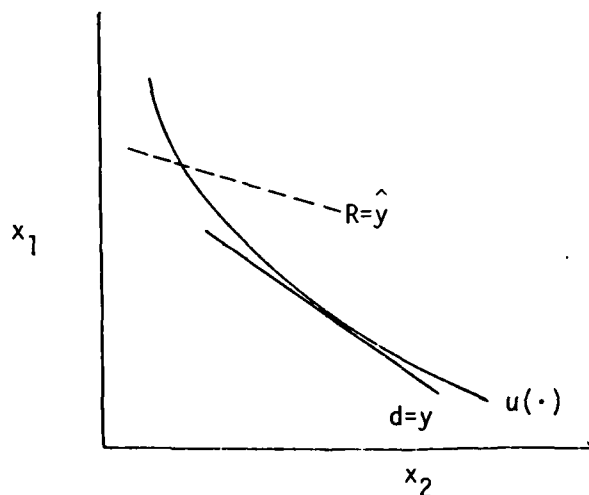
FIGURE 14

"TRUE" INDEX RELATIONSHIP

We can now apply these utility relationships to the problem of
measuring relative levels of U.S. and Soviet defense expenditures.

In this analysis the military decision maker (defined in some
aggregate sense) is treated as a consumer. U.S. and Soviet decision

makers are different consumers with different preference mappings.

U.S. Preference Structure

Figure 15 illustrates the utility based definition of the true

index, where

X^S = SU force mix

y^S = dollar cost of X^S

X^u = U.S. force mix

y^u = dollar cost of X^u

X^* = a tangency force structure equivalent (in terms of U.S. preferences) to X^S

y^* = dollar cost of X^*.
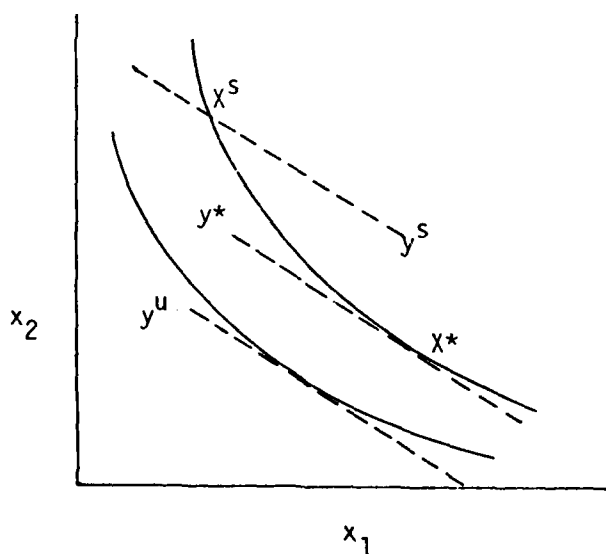
FIGURE 15

U.S. PREFERENCE MAPPING

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Note that $y^S \geq y^*$. The value y^* is the *true dollar value* of Soviet defense expenditures, and y^*/y^U is called the *true dollar index*, and is denoted as T_D. The quantity y^S/y^U is called the *estimated dollar index*, and is denoted as E_D. Since $y^S \geq y^*$, it follows that the estimated index always *overestimates* the true index ($E_D \geq T_D$). The estimate E_D resembles a Laspeyres quantity index since it is computed as $P^U X^S / P^U X^U$. As in the Laspeyres index, the price weights correspond to the denominator quantities. If $E_D < 1$, then the U.S. position, X^U, is clearly preferable (to the U.S. decision maker) to the Soviet position, X^S. This is analogous to the result that if the Laspeyres quantity index ($P_0 X_1 / P_0 X_0$) is less than one, then the base year quantities are preferable to given year quantities (assuming the same preference map in each year).

Soviet Preference Structure

Figure 16 illustrates the true index based on the Soviet preference structure,[3] where

X^S = Soviet force structure

r^S = ruble cost of X^S

X^U = U.S. force structure

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[3] Note that the true index based on the U.S. preference map is generally different than the true index based on the Soviet preference map. The conditions necessary for equality are discussed in a later section.

r^u = ruble cost of X^u

X' = a tangency force structure equivalent (in terms of Soviet preferences) to X^u

r' = ruble cost of X'.
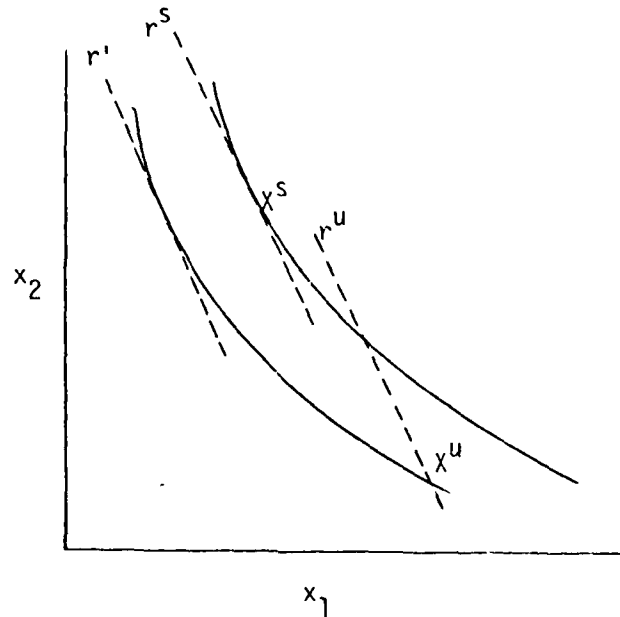
FIGURE 16

SOVIET PREFERENCE MAPPING

Note that $r^u \geq r'$. The value r' is the minimum ruble expenditure required for the Soviets to purchase a force structure equivalent (in terms of Soviet preferences) to the U.S. mix, X^u. This value, r', is called the *true ruble value* of U.S. defense expenditures, and r^s/r' is called the *true ruble index*, and is denoted as T_R. The quantity r^s/r^u is called the *estimated ruble index*, and is denoted as E_R. Since $r^u \geq r'$, it follows that the estimated index always

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underestimate the true index ($E_R \leq T_R$). The estimate E_R resembles a Paasche quantity index since it is computed as $P^S X^S / P^S X^U$. If $E_R > 1$, then the Soviet position, X^S, is clearly preferable (to the Soviet decision maker) to the U.S. position, X^U. This is analogous to the result that if the Paasche quantity index ($P_1 X_1 / P_1 X_0$) is greater than one then the given year quantities are preferable to the base year quantities (assuming the same preference map in each year). Table 7 summarizes these results.

TABLE 7

SU/US EXPENDITURE INDICES

	Dollar	Ruble
True	$T_D = y^* / y^U$	$T_R = r^S / r'$
Estimated	$E_D = y^S / y^U$	$E_R = r^S / r^U$
Relations	$E_D \geq T_D$	$E_R \leq T_R$
	$E_D < 1 \rightarrow$ U.S. superior by U.S. preference	$E_r > 1 \rightarrow$ SU superior by SU preferences

In the general case of different (and, for emphasis, quite different) preference maps the dollar index, T_D, and its estimate, E_D, are of interest to the U.S. decision maker, but the ruble indices have

little meaning to the U.S. official.[4]

According to this analysis, in the more realistic case of two different utility functions, the U.S. decision maker (considering only the value of E_D) can never say with certainty that the Soviet Union is in a preferred position with respect to U.S. preferences. He has only a sufficient condition for the U.S. position to be preferred in terms of U.S. preferences (i.e., $E_D \leq 1$). (From the basic characteristics of utility functions, the decision maker's choice of the basket of Soviet defense goods over the corresponding U.S. basket is sufficient to conclude Soviet superiority, however.)

The complete set of possibilities are

$E_R > 1$: This implies $T_R > 1$, and hence, the Soviet Union is ahead of the U.S. in terms of Soviet preferences.

$E_R < 1$: T_R could be greater than or less than one, and hence, no conclusion can be drawn.

$E_D < 1$: This implied $T_D < 1$, and hence, the U.S. is ahead of the Soviet Union in terms of U.S. preferences.

$E_D > 1$: T_D could be greater than or less than one, and hence no conclusion can be drawn.

Common Preference Structure

As a simplifying approximation, consider the Soviet and U.S. preference structures to be sufficiently similar that they can be

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[4]The meaning to the U.S. of the Soviet indices is derived from its effect on Soviet perceptions of the related level of defense expenditures. These perceptions indirectly influence the ordinal value of the utility of U.S. defense expenditures.

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treated as identical. In this case both the ruble and the dollar indices are meaningful (both true and estimated) to the U.S. decision maker. If either true index is greater than one then so is the other. Also, if the Soviet Union is on a higher indifference curve, both true indices are greater than 1 (and *vice versa*). Since the true indices are unknown, however, one must deal with the estimates. Since the estimated ruble index is less than the true ruble index, when the estimated ruble index is greater than 1, the Soviet position is preferred to that of the U.S. (by either decision maker, since their preference structures are assumed to be the same).

Now consider what conclusions could be drawn from the current actual U.S. and Soviet expenditure levels if their preference structures were the same. Since the currently estimated ruble index is approximately 1.2, it must be concluded that the Soviet Union is on a higher indifference curve than the U.S. As previously shown, if the Soviets are on a higher curve, then the true dollar index is greater than one. Since the estimated dollar index exceeds the true value, one can conclude that when the Soviet position is preferred to the U.S. position, the estimated ollar index exceeds one. This result is also consistent with current estimates ($E_D = 1.45$).

In summary, under the common preference structure assumption,

Higher SU ruble expenditures $= > T_R > 1 = >$ SU higher curve ($E_R > 1$)

$= > T_D > 1 = >$ Higher SU dollar expenditures ($E_D > 1$).

When the assumption of a common preference structure may be valid, one must deal with the dilemma of two different true indices-- T_D, a ratio of dollars, and T_R, a ratio of rubles. Each index is meaningful (under the common preference assumption), but which, if either, is more meaningful? The estimate E_R provides a lower bound on T_R, and E_D is an upper bound on T_D. One way to combine these indices would be to form a Fisher's index, $(T_D \times T_R)^{\frac{1}{2}}$, with the hope of thereby capturing information in each of the values, T_D and T_R. However, the estimate of this index, $(E_D \times E_R)^{\frac{1}{2}}$, cannot be related to $(T_D \times T_R)^{\frac{1}{2}}$ in the sense of either an upper or a lower bound.

An alternative approach is to assume that the true indices, T_D and T_R, are in fact identical. Conditions for the validity of this assumption are given in the next section. Under this assumption one obtains the simplification that the estimate E_R is a lower bound and E_D is an upper bound. That is,

$$E_R \le T_R = T_D \le E_D. \tag{84}$$

The conditions necessary for such an assumption will not be developed.

Sufficient Conditions for $T_D = T_R$

Let R_+^k denote the nonegative orthant of R^k. Let

$$V(p,y) = \max u(x_1,x_2), \text{ s.t.}^5 \tag{85}$$

$$p\, x_1 + x_2 = y$$

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[5]$V(p,y)$ is the utility "produced" by the consumer who confronts price p (good x_1 relative to good x_2) and income y.

$$x_1, x_2 \geq 0$$

where $u(x_1,x_2)$, with respect to R_+^2, is a strictly concave coordinate-wise increasing common utility function. The parameter p is the relative price of x_1 in terms of x_2, and the parameter y is the budget. Suppose the underlying utility structure is such that the following condition is satisfied

There exists a function $K(\alpha):R_+ \to R_+$

$$\frac{V(w,\alpha z)}{V(w,z)} = K(\alpha) \text{ for all } w \geq 0, z \geq 0. \tag{86}$$

This condition means that multiplying the budget by α has the same effect on the preference level (multiplies it by $k(\alpha)$), regardless of whether budget (and prices) are initially expressed in rubles or dollars (i.e., regardless of the values of budget and prices). As an example, suppose $u(x_1,x_2) = (x_1 x_2)^{\frac{1}{2}}$, then

$$v(p,y) = \max (x_1 x_2)^{\frac{1}{2}}, \text{ s.t.}$$
$$p\, x_1 + x_2 = y$$
$$x_1, x_2 \geq 0.$$

It is easy to verify that

$$v(p,y) = \frac{y}{2(p)^{\frac{1}{2}}} \cdot$$

Hence,

$$V(w, \alpha z) = \frac{\alpha z}{2(w)^{\frac{1}{2}}}$$

By taking $K(\alpha) = \alpha$, it is seen that condition (86) is satisfied.

It will now be shown that this condition implies that $T_D = T_R$ where, referring to Figures 15 and 16, $T_D = y^*/y^u$ and $T_R = r^S/r'$. Letting p_R and p_d denote price relatives for the Soviet Union and for the U.S., respectively,

$$V(p_D, y^*) = V(p_R, r^S) \tag{87}$$

where

$$V(p_D, y^*) = u(x_1^*, x_2^*) = \max u(x_1, x_2), \text{ s.t.}$$

$$p_D x_1 + x_2 = y$$

$$x_1, x_2 \geq 0$$

$$V(p_R, r^S) = u(x_1^S, x_2^S) = \max u(x_1, x_2), \text{ s.t.}$$

$$p_R x_1 + x_2 = r^S$$

$$x_1, x_2 \geq 0. \tag{88}$$

Also, $V(pD, y^u) = V(p_R, r')$

where

$$V(p_D, y^u) = uIx_1^u, x_2^u) = \max u(x_1, x_2), \text{ s.t.}$$

$$p_D x_1 + x_2 = y^u$$

$$x_1, x_2 \geq 0$$

$$V(p_R, r') = u(x_1', x_2') = \max u(x_1, x_2), \text{ s.t.}$$

$$p_R x_1 + x_2 = r'$$

$$x_1, x_2 \geq 0.$$

Now let $= y^*/y^u$, or $y^* = y^u$, then

$$V(p_R, r^S) = V(p_D \cdot y^*) = V(p_D, \alpha y^u) = K(\alpha) V(p_D, y^u) = K(\alpha) V(p_R, \alpha r'). \tag{89}$$

The assumption on the utility function, u, imply that V is one-to-one in the second argument and hence, $r^S = \alpha r''$. Thus it has been shown that

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$$y*/y^u = \alpha = r^S/r'.$$

Actually, condition (86) is unnecessarily strong, since all that is required is that

$$\text{for all } \alpha, \quad \frac{V(p_D, \alpha y^u)}{V(p_D, y^u)} = \frac{V(p_R, \alpha r')}{V(p_R, r')}. \tag{90}$$

Intertemporal, Cross-Country
Indices

This section examines the conditions that are commonly assumed to be necessary and sufficient to conclude that the growth rate in Soviet defense spending exceeds the growth rate of U.S. defense spending. Later it will be shown that the classical conditions imply the set of assumptions necessary for $T_R = T_D$. In this analysis, a subscript added to the price and the quantity vector will be used to designate the period (i.e., [1] refers to the final period and [2] refers to the base period).

Again, using the vector format

$$\frac{I_s^S}{I_s^u} = \frac{P_1^S x_1^S / P_1^S x_1^u}{P_0^S x_0^S / P_0^S x_0^u} \tag{91}$$

$$= \frac{P_1^S x_1^S / P_0^S x_0^S}{P_0^S x_0^S / P_0^S x_0^u} \tag{92}$$

where, for example, I_s^u refers to the time index of U.S. quantities weighted by Soviet prices.

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The classical conditions for Soviet defense spending growth to exceed that of the U.S. are

$$\frac{I^S_s}{I^u_s} > 1$$

or

$$\frac{I^u_s}{I^s_s} < 1 \qquad \text{(condition 3)} \qquad (93)$$

and

$$\frac{I^s_u}{I^u_u} > 1 \qquad \text{(condition 4)} \qquad (94)$$

where

$$\frac{I^s_u}{I^u_u} = \frac{P^u_1 X^s_1 / P^u_1 X^u_1}{P^u_0 X^s_0 / P^u_0 X^u_0} \qquad (95)$$

$$= \frac{P^u_1 X^s_1 / P^u_0 X^s_0}{P^u_1 X^u_1 / P^u_0 X^u_0} . \qquad (96)$$

Condition 3 states that the ratio of Soviet defense spending in the final year to that in the base year (using Soviet relative prices) must exceed the U.S. ratio (using Soviet relative prices). Similarly, condition 4 states that the ratio of Soviet defense spending in the final year to that in the base year (using U.S. relative prices) must exceed the U.S. ratio (using U.S. relative prices).

Consider only a price index of Soviet expenditures growth under dollar weights and let

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$$w_i = p_{i0}^u x_{i1}^S.$$

Then,

$$I_s^u(p) = \frac{p_1^u x_1^S}{p_0^u x_1^S} \tag{97}$$

$$= \frac{\sum_i w_i (p_{i1}^S / p_{i0}^S)}{\sum_i w_i}. \tag{98}$$

Similarly, for a price index of Soviet expenditure growth, using ruble weights and letting

$$w_i' = p_{i0}^S x_{i1}^S.$$

one obtains

$$I_s^S(p) = \frac{p_1^S x_1^S}{p_0^S x_1^S} \tag{99}$$

$$= \frac{\sum_i w_i' (p_{i1}^S / p_{i0}^S)}{\sum_i w_i'}. \tag{100}$$

Again, the subscript 1 refers to the final period and the subscript 0 refers to the base period.

The time related index numbers (and related biases) are a function of the weights. Only if $p_0^u x_1^S = p_0^S x_1^S$ will there be no bias. The direction of the differences between the two indices is a function

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of the different weights and the ratio of the relative prices between conventional and advanced armament for the two time periods, P_1^S/P_0^S.

Trade Restrictions

When goods can be traded between countries, purchasing power parity in res that a traded good will have the same price in each coun , except for differences caused by taxes, transportation costs, and other related factors). That is

$$P_{1i} = P_{2i} \times e_{1/2} \tag{101}$$

where

P_{1i} = price of good i in country 1

P_{2i} = price of good i in country 2

$e_{1/2}$ = the exchange rate between currencies of country 1 and country 2.

If the conditions above did not hold then arbitrage opportunities in good i would exist. A natural outcome of the arbitrage process would be the elimination of such opportunities.

If defense goods in the United States and the Soviet Union were freely traded, then purchasing power parity would hold and the same relative prices between defense goods would hold in each country. Such is not the case. Since most of the technically advanced hardware is produced solely in either the U.S. or the Soviet Union, such trade can be, and is, restricted.

For non-traded goods the equilibrium quantity is determined by the intersection of the supply and demand curves for that good, i.e., the quantity supplied must equal the quantity demanded in each country. The structure of relative prices for such goods can vary between countries due to such factors as differences between the resource bases in the countries and between the tastes and preferences between the commodity users.

For normal goods, prices and quantities are inversely related. If the relative quantity of a non-traded good differs between countries, then the price of that good would tend to be more expensive in the country with the lower quantity. This assumes that the price-quantity relationship dominates the effects of differing resource bases and *productivity* levels in the two countries.

If we assume the same two-good defense production used in the earlier discussion (i.e., conventional and advanced) the effects of differences in relative prices follows the previous analysis. Using U.S. price relatives, the defense expenditures of the Soviet Union would be overstated relative to the expenditures using Soviet price relatives.

For example, assume that x_1 in the U.S. = 5 and x_2 = 10 and in the Soviet Union x_1 = 10 and x_2 = 5. If the price of x_1 in terms of x_2 in the United States is 1 and the same price relative in rubles is 2, then the following index values result:

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$$I_1 = \frac{p_1^s x_1^s + x_2^s}{p_1^s x_1^u + x_2^u}$$

$$= \frac{2(10) + 5}{2(5) + 10} = 1.25$$

$$I_2 = \frac{p_1^u x_1^s + x_2^s}{p_1^u x_1^u + x_2^u}$$

$$= \frac{1(10) + 5}{1(5) + 10} = 1.00.$$

A Fisher's ideal index would have the following value:

$$I_F = (1.00 \cdot 1.25)^{\frac{1}{2}} = 1.118.$$

According to these results, Soviet spending on defense exceeds U.S. defense spending when using Soviet price relatives. When using U.S. relatives, Soviet and U.S. spending are equivalent. The Fisher's index shows Soviet spending exceeding that of the U.S.

If in the following period the actual quantities of conventional and advanced armaments doubled in both the Soviet Union and in the United States then, the relative growth indices developed earlier would yield

$$\frac{I_s^s}{I_s^u} = \frac{(2(20) + 10)/(2(10) + 5)}{(2(10) + 20)/(2(5) + 10)} = 0.60$$

$$\frac{I_u^s}{I_u^u} = \frac{(1(20) + 10)/(1(10) + 5)}{(1(10) + 20)/(1(5) + 10)} = 1.00.$$

In the classical analysis, for the growth of Soviet defense spending to be considered greater than that of the U.S., both relatives must be greater than one. Conversely, for the growth in U.S. spending to be considered greater than that of the Soviet Union, both relatives must be less than one. This example illustrates the different results possible when the relative prices of the countries are not the same. Again, this form of analysis implies the same utility function for the two countries.

Utility Considerations

Another possible method for analyzing the biases involved in time variant indices for a given country or between countries is similar to the utility analysis of an earlier section. The problem addressed is the identification of a "true" defense cost index. Such an index would resolve the baises inherent in the indices defined by Equations 92 and 95.

In an analysis similar to that proposed by Fisher and Shell, the levels of income necessary for the consumer to remain on an indifference curve, given the base year expenditure and the vector of prices for both the base and the final year was compared. In the earlier analysis we used an example in which the level of expenditures for the Soviet Union, using their price relatives, were transformed, holding utility constant, to a new maximum point which reflected U.S. price relatives.

In modifying this form, one needs only to consider the new price relatives as representing changed internal factors rather than the price structure of a different country.

Thus, given the base year prices of defense goods, $\hat{p}_1$, $\hat{p}_2$, ..., $\hat{p}_n$, and level of defense expenditure, $\hat{y}$, and the current price of goods, p_1, p_2, ..., p_n, our problem is to find that income, y, such that the defense consumer is currently indifferent between facing current prices with an income, y, and facing base period prices with the base period income, $\hat{y}$. The ratio, $y/\hat{y}$, represents that proportion of the change in defense expenditures that reflect only cost-of-living effects.

If Y is the current level of defense expenditures, then

$$\frac{\dfrac{Y}{\hat{y}}}{\dfrac{y/\hat{y}}{\hat{y}}} = Y/y \tag{102}$$

represents the *real* increases in defense expenditures. What one has done is to isolate the income effect of intertemporal price movements as a residual of the Hick's methodology for isolating the substitution effect.

Thus, if the growth of defense expenditures in the Soviet Union exceeds the growth in the United States, in *real* terms, the ratio

$$\frac{Y^s/y^s}{Y^u/y^u} > 1 \tag{103}$$

This index relationship captures the effects of both conditions 3 and 4 without the inherent biases in either of them.

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More pragmatically, this same result can be obtained by analyzing the changing bias $(T_D - E_D)$ over time.

Historically, e.g., twenty years ago, one could argue that $p_2^s \gg p_2^u$ and that the U.S. defense posture was clearly superior. In the extreme, then, U.S. and Soviet total costs and quantities can be illustrated as in Figure 17.
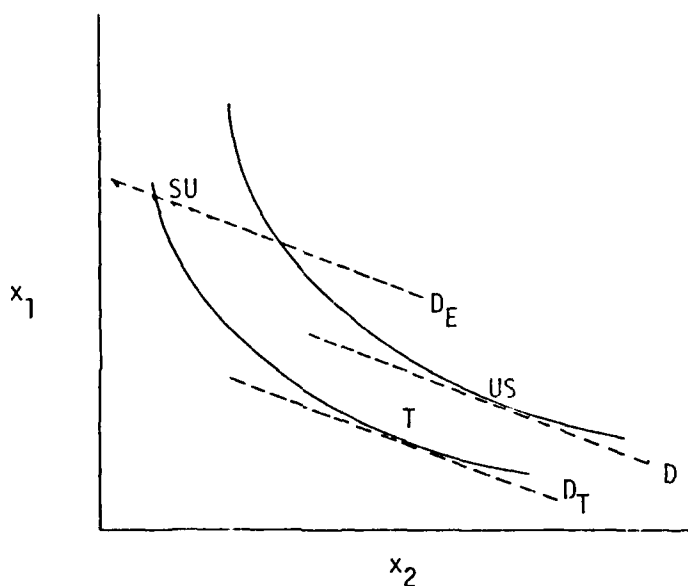
FIGURE 17

HYPOTHETICAL US-SU DEFENSE
COMPARISON--20 YEARS AGO

In Figure 17, D denotes the value of U.S. defense expenditures, D_E is the estimated and D_T the true value of Soviet defense expenditures, all in terms of U.S. price relatives (and U.S. preference structure). In this example, the Soviets possessed a numerically

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larger number of conventional armament, x_1, and a smaller amount of advanced weapons, x_2, than did the U.S.

As illustrated, the upward bias in D_E is so great compared to the true value, D_T, that Soviet defense expenditures appear to exceed the level of U.S. expenditures, in terms of U.S. price relatives.

In contrast, one can argue that the current U.S. and SU mixes are much closer in proportionate composition (the line segment joining the two mixes subtends a smaller angle with the origin). Figure 18 is a possible representation of this scenario, with the primes denoting the current period.
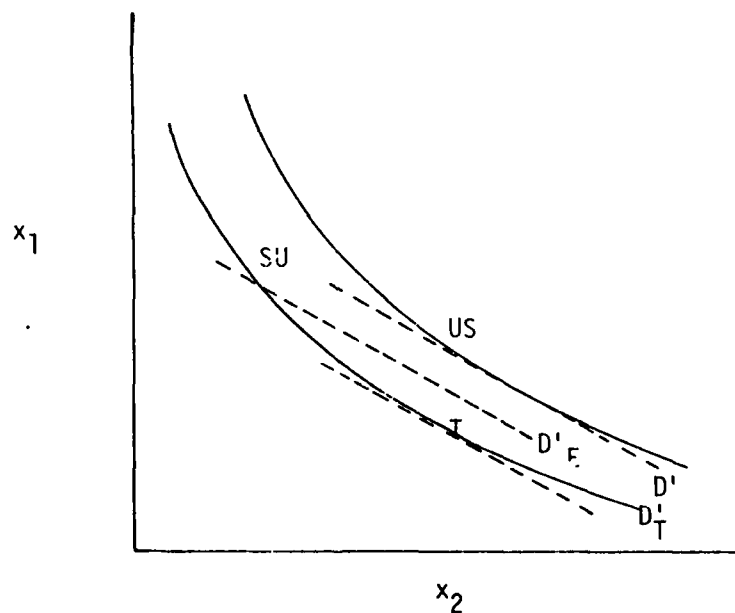
FIGURE 18

HYPOTHETICAL US-SU DEFENSE
COMPARISON--CURRENT

Comparing the relationships in Figures 17 and 18 one finds that, in terms of a constant price level

$$D_E - D_T > D_E' - D_T' \tag{104}$$

This heuristically derived result follows from the assumption that the Soviet price relative, p_2^S, has historically been moving closer to the U.S. price relative, p_2^u.

Graphically, this historical diminution of the bais error in the estimates of the growth rate of Soviet defense expenditures is depicted in Figure 19 for a hypothetical base year (B) and final year (F).
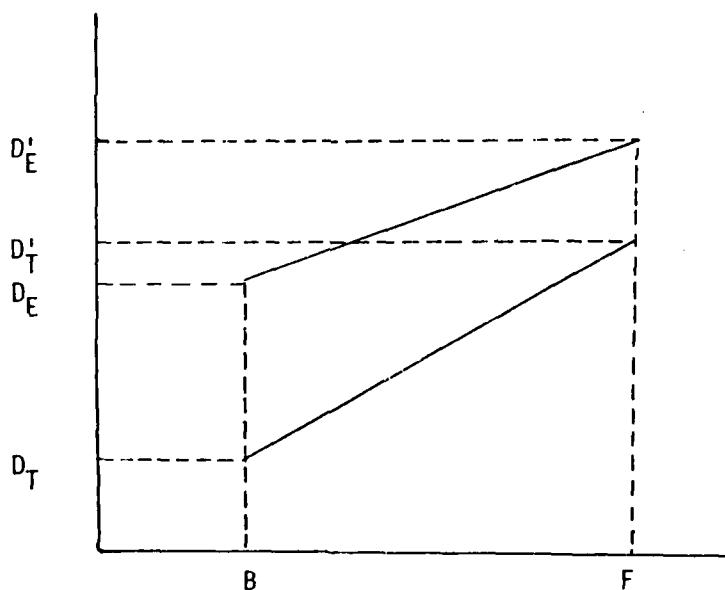
FIGURE 19

HYPOTHETICAL SU DEFENSE GROWTH RATE

This analysis suggests, that is, the U.S. and Soviet mixes have been historically becoming more similar (proportionately), then the growth rate of estimated Soviet dollar expenditures (measured in constant dollars) is a *lower bound* on the true growth rate. Under the same conditions, along with the assumptions of a common preference structure and the speical assumptions necessary for $T_R = T_D$, one can find an *upper bound* on the true growth rate as follows.

The previous assumptions guarantee that, in terms of indices,

$$E_D > T > E_R \qquad (105)$$

or

$$D_E/D > D_T/D > R/R_E \qquad (106)$$

where

D_E = estimated SU dollar value

D = U.S. dollar expenditure

D_T = true SU dollar value

R = SU ruble expenditure

R_E = estimated U.S. ruble value.

Consequently, $D_T > D \cdot E_R$, or $D_T > D \cdot R/R_E$.

As the U.S. and the Soviet price relatives, P_2, become more similar (i.e., as the dollar ratio and the ruble ratio become more similar) it must be that $D_T \rightarrow D \cdot E_R$. Consider Figure 20.

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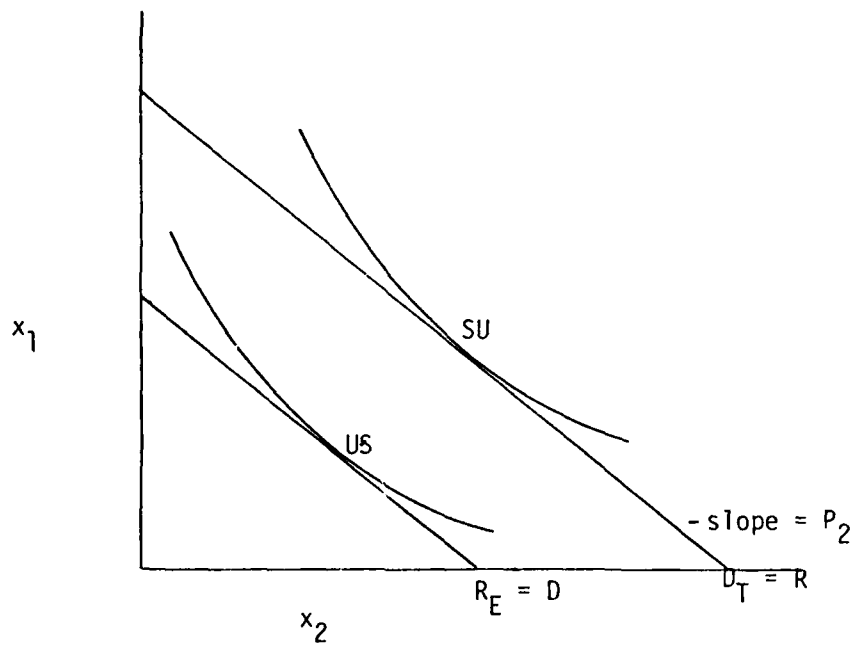
FIGURE 20

IDENTICAL US-SU PREFERENCE MAPS

Thus,

$$\frac{D_T}{D} = \frac{R}{R_E}$$

or

$$D_T = D \cdot R/RE. \tag{107}$$

Consequently, Figure 19 can be modified as follows:

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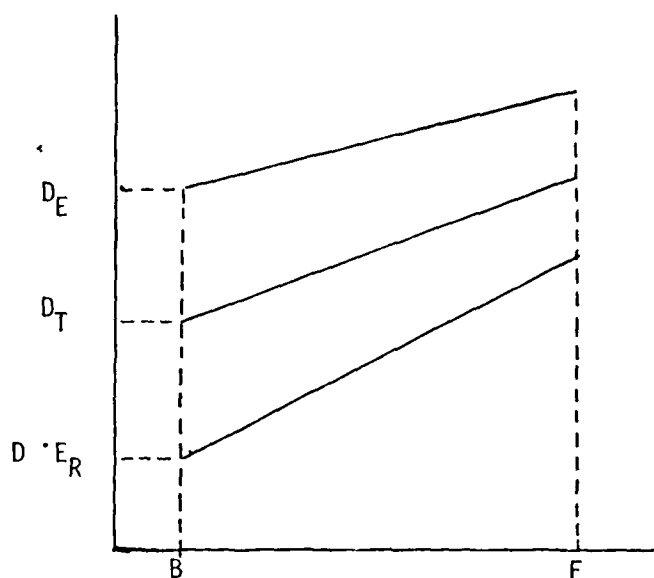
FIGURE 21

TWO-SIDED BOUNDS ON GROWTH RATE

It should be noted that both bounds are computable. Although the upper bound on growth rate (i.e., the slope of the $D \cdot R/R_E =$ $D \cdot E_R$ values, which are a lower bound on D_T) depends on several special assumptions, the lower bound is reasonable under quite general conditions.

Alternative Index Forms

This section presents the theoretical development of alternative index forms. The true index is rederived in a framework that can be compared with index relationships developed in the economics

literature which provide second order approximations to the true index. Several new forms are presented, based on the relationship between true and the Laspeyres indices.

Consider two commodity bundles, X_i and X_j, each acquired at different points in time or space by a consumer facing different price systems, say P_i and P_j, and endowed with different incomes, y_i and y_j. It is assumed that the consumer's preference structure is the same during the acquisition of X_i and X_j. In terms of this preference structure, one wishes to estimate the value of the bundle X_i, relative to X_j, where, for specificity, this valuation will be in terms of the prices P_j. The quantity X_i lies on one of the consumer's indifference curves, and the hyperplane with normal P_i is tangent to this curve at X_i. Call this curve u_i. The bundle X_j lies on another indifference curve, say u_j, where the hyperplane with normal P_j is tangent. For exposition, assume two goods, x_1 and x_2 with the relationship depicted in Figure 22. The following analysis is independent of whether or not $u_i > u_j$. Let $u(x)$ denote the consumer's utility function. Thus the consumer faces the problem

$$\max_x u(x), \text{ s.t.} \tag{108}$$

$$px \geq y$$

$$x \geq 0.$$

Let $x(y,p)$ denote the consumer's demand function, where $x(y,p)$ is the solution to the above problem. Also let $C(U,p)$ denote the consumer's cost function, which is the cost of achieving utility U at

prices p. Hence

$$y = C(U,p) = \min px, \text{ s.t.} \tag{109}$$

$$u(X) \geq U$$

$$x \geq 0.$$

Let $x(U,p)$ denote a solution to this problem. Then, as Figure 22 shows, these definitions imply

$$x(u_k, P_k) = x(y_k, p_k), \quad k = i,j \tag{110}$$

$$C(u_k, P_k) = P_k x_k = y_k, \quad k = i,j.$$
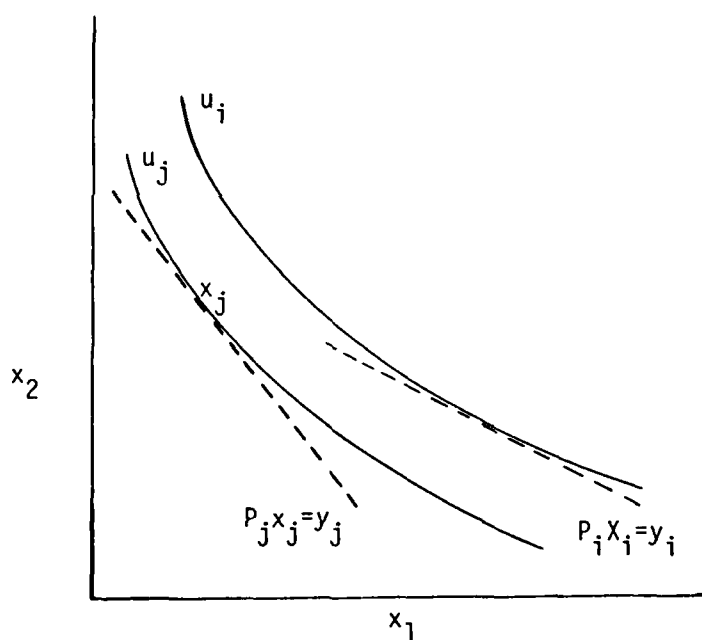
FIGURE 22

HYPOTHETICAL PREFERENCE MAP

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The true index, T, which we wish to estimate is

$$T = \frac{\text{cost of } u_j \text{ at prices } P_i}{\text{cost of } u_i \text{ at prices } P_i} = \frac{C(u_j, p_i)}{C(u_i, p_i)} = \frac{C(u_j, P_i)}{P_i X_i} \qquad (111)$$

A result of interest is

$$C(U, p) = \hat{x}(U, p)$$

which is known as Sherperd's Lemma. Also, the consumer's cost function, C, is concave in p and convex in U. The Laspeyres estimate of the true index, T, is the quotient

$$L = \frac{P_i X_j}{P_i X_i} \qquad (112)$$

From Figure 22 it is clear that $P_i X_j > C(u_j, P_i)$, and hence L exceeds T. It will now be shown analytically that this is always true. We have

$$C(u_j, P_i) = C(u_j, P_j + (P_i - P_j)) \leq \qquad (113)$$

$$C(u_j, P_j) + C_p(u_j, P_j)(P_i - P_j)$$

The inequality follows from the concavity of C in P. Using Shepherd's Lemma,

$$C(u_j, P_i) \leq y_j + C_p(u_j, P_j)(P_i - P_j) = \qquad (114)$$

$$y_j + \hat{x}(u_j, P_j)(P_i - P_j).$$

Hence,

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$$T = \frac{C(u_j, P_i)}{y_i} \leq \frac{y_j + \hat{x}(u_j, P_j)(P_i - P_j)}{y_i} \quad (115)$$

$$= (y_j + X_j(P_i - P_j))/y_i = (y_j + X_j P_i - y_j)/y_i$$

$$= \frac{P_i X_j}{P_i X_i} = L.$$

Additional Estimates of T

Two other indices that have appeared in previous literature, and two additional forms that are related to L, are possible alternative index forms. From the above analysis the subscript i will be replaced by u (for U.S.) and j by s (for SU).

The Thiel - Törnqvist - Koek Index, denoted as E_4 in this study, had been advocated by many writers because it includes some second order effects to non-linear functions, a property not provided by the Laspeyres estimate (see, for example, Theil, 1965; 1968; and Diewert, 1976). This index has the formula

$$E_4 = \prod_{j=1}^{n} (x_j^s / x_j^u)^{\frac{1}{2} (\gamma_j + \overline{\gamma}_j)} \quad (116)$$

where

$$\gamma_j = \frac{p_j^u x_j^u}{p^u x^u}, \text{ and } \overline{\gamma}_j = \frac{p_j^s x_j^s}{p^s x^s}.$$

The Palgrave Index, denoted E_3, is given as

$$E_3 = \prod_{j=1}^{n} (x_j^s/x_j^u)^{\gamma_j} \ , \ \gamma_j = \frac{p_j^u \ x_j^u}{p^u \ x^u} \ . \tag{117}$$

If the underlying U.S. utility function follows the Cobb-Douglas form

$$u(x) = \prod_{j=1}^{n} (x_j)^{\gamma_j} \ , \ \gamma_j = \frac{p_j^u \ x_j^u}{p^u \ x^u} \tag{118}$$

then, it can be shown that the value of T is given exactly by E_3. Also, using concavity of E_3 on the nonnegative orthant, we have

$$E_3 = \prod_{j=1}^{n} (x_j^s/x_j^u)^{\gamma_j} \le \sum_{j=1}^{n} \gamma_j (x_j^s/x_j^u) \tag{119}$$

$$= \sum_{j=1}^{n} \frac{p_j^u \ x_j^u}{p^u \ x^u} (x_j^s/x_j^u) = \frac{p^u \ x^s}{p^u \ x^u} = L$$

i.e., $E_3 \le L$.

A new index, denoted E_2, and defined as

$$E_2 = (P^s \ x^s + \sum_{j=1}^{n} p_j^s \ x_j^s \ \ell n(p_j^j/p_j^s))/(P^u \ x^u) \tag{120}$$

is motivated by the fact that $T \le L$, as already shown, and $E_2 \le L$, as will now be shown.

Using the fact that $\ell n \ X \le X-1$, we have

$$\ell n(p_j^u/p_j^s) \le \frac{p_j^u - p_j^s}{p_j^s} \tag{121}$$

and thus,

$$E_2 \leq (P^W X^S + \sum_{j=1}^{n} p_j^S x_j^S (\frac{p_j^u - p_j^S}{p_j^S}))/(P^u X^u) = L. \tag{122}$$

Another possible index, E_1, is defined as

$$E_1 = (P^u X^u + \sum_{j=1}^{n} p_j^u x_j^u \ln(x_j^S/x_j^u))/(P^u X^u). \tag{123}$$

Using the fact that

$$\ln(x_j^S/x_j^u) \leq \frac{x_j^S - x_j^u}{x_j^u} \tag{124}$$

one obtains

$$E_1 \leq (P^u X^u + \sum_{j=1}^{n} p_j^u x_j^u \frac{(x_j^S - x_j^u)}{x_j^u})/(P^u X^u) = L. \tag{125}$$

The fact that $E_1 \leq L$ motivates its definition. Also,

$$E_1 = 1 + \sum_{j=1}^{n} \gamma_j \ln(x_j^S/x_j^u) = \ln E_3 + 1 \leq E_3. \tag{126}$$

Thus, the following relations exist among E_1, E_2, E_3, L, and T:

$$T \leq L \tag{127}$$

$$E_1 \leq E_3 \leq L$$

$$E_2 \leq L.$$

Numerical Tests

The indices L and E_i, $i = 1,2,3,4$, were computed on contrived data for total U.S. and Soviet forces, using ten categories of forces

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in classes analogous to those appearing in the DoD Five Year Defense Program Structure. The data were designated to cover a wide spectrum of expenditures and price levels. Three data sets were constructued.

In Data Set I Soviet quantities exceed U.S. quantities in most categories. The data are presented in Table 8. In order to obtain a value for the true index, a Cobb-Douglas utility function for the U.S. planner

$$u(x) = \prod_{j=1}^{n} x_j^{\gamma_j} \tag{128}$$

was assumed to underlie these data. If the parameters γ_j are defined as

$$\gamma_j = p_j^u x_j^u / (P^u X^u) \tag{129}$$

then the X^u values in Table 8 can be shown to solve the optimization problem

$$\max \prod_{j=1}^{n} x_j^{\gamma_j}, \text{ s.t.} \tag{130}$$

$$\prod_{j=1}^{n} p_j^u x_j^s \leq \sum_{j=1}^{n} p_j^u x_j^u$$

$$x_j \geq 0, \text{ all } j.$$

Using this utility function, the values of T and E_3 are identical. This value was calculated, along with values of L and E_1, E_2, and E_4. The results appear in Table 8.

In Data Set II, U.S. quantities exceed Soviet quantities in most categories. The values for X^u, P^u, and P^s are the same as in

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TABLE 8

DATA SET I

Category	q^{US}	q^{SU}	p^{US}[1]	p^{SU}[2]
Strategic Forces (SF)	1,000	1,500	10	8
General Purpose Forces (GPF)	10,000	12,411	4.7	2.82
Intelligence and Communication (IC)	90	108	92.2	69.15
Research and Development (RD)	13,750	20,800	.8	.72
Air and Sea (AS)	180	430	10	7
National Guard and Reserve (GR)	1,426	1,590	4.7	2.82
Central Supply and Maintenance (CSM)	1,280,000	1,230,000	.010	.0065
Training and Medical (TM)	520,000	431,000	.050	.0325
Administration (AD)	24,000	33,000	.1	.06
Support of Other Nations (SON)	30	57	10	7

[1] p^{US} is in millions of dollars.

[2] p^{SU} is in millions of rubles.

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Data Set I, and are given in Table 8. The values for X^S are shown in Table 9.

TABLE 9

DATA SET II

Category	q^{SU}
SF	500
GPF	13,000
IC	50
RD	5,000
AS	100
GR	1,500
CSM	700,000
TM	400,000
AD	20,000
SON	20

The computational results are shown in Table 11.

In Data Set III, Soviet quantities exceeded U.S. quantities in conventional categories and U.S. quantities exceeded Soviet quantities in advanced categories. The Soviet quantities were chosen in such a way that X^S and X^u are on the same indifference curve of $u(x)$, as defined earlier. The data for X^u and P^u are the same as in Table 10. The remaining data are given in Table 8.

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TABLE 10

DATA SET III

Category	q^{SU}	p^{SU} (millions of rubles)
SF	1,650	5
GPF	13,000	2.983
IC	90	76.03
RD	10,000	.908
AS	400	3.711
GR	1,500	3.682
CSM	800,000	.01321
TM	350,000	.06125
AD	30,000	.06585
SON	50	5.016

The computational results for this data set also appear in Table 11.

TABLE 11

VALUES FOR T, L, AND ALTERNATIVE INDICES

	$T = E_3$	L	E_1	E_2	E_4
Data Set I	1.17	1.279	1.155	1.195	1.148
Data Set II	.797	.958	.751	.883	.859
Data Set III	1.0	1.146	.999	1.06	.999

In this very limited experiment E_1 is seen to provide a consistent and rather sharp lower bound for T. The Laspeyres estimate L has

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considerable overbias. The Thiel-Törnqvist-Kloek estimate E_4 performs well in all three cases.

Additional Testing

Given a set of quantity and price data, say (x_i, p_i), $i = 1, 2,$ ..., n, a necessary and sufficient condition exists for this data to be consistent with the utility maximization hypothesis, i.e., for there to exist a utility function, $u(X)$, such that X is a solution to the consumer problem

$$\max u(X), \text{ s.t.}$$

$$p_i x_j \leq p_i x_j$$

$$x_i \geq 0. \quad (i,j = 1,2,\ldots,n).$$

The necessary and sufficient condition for the existence of an underlying utility function is that a certain linear programming problem has an optimal value of zero (see Afriat, 1967; Diewert, 1973). Moreover, the linear program actually provides the data to construct an underlying utility function, $u(x)$, with which the given data is consistent. (Assuming, of course, that if the price-quantity data are from different time periods, the planner's utility structure is temporally stable.) In this way, one can impute a utility function to the U.S. planner,[4] and the desired ratio, $P^u X^{s*}/(P^u X^u)$, can then be

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[4]There is no need in this development to be concerned with a utility function for the SU planner or with the related question of whether or not his function is similar to that of the U.S. planner. We are concerned with the military worth (utility) to the U.S. planner of the SU force. That is, we want to determine the mix on indifference

constructed and compared with the Laspeyres form, $P^u X^s/(P^u X^u)$.

This theory was exercised by Gould and Laffer (Note 2) on a set of un-classified summary data made available by the CIA of U.S. and SU surface combatant ships. The quantities for the U.S. and the SU used in the analysis (total carrier tons, total cruiser tons, total destroyer tons, total frigate tons([7] were for the years 1967-1977. A dollar price/ton was derived for each ship type in each of these years and an underlying utility function was derived. The results appear in Table 12.

It should be noted that the Laspeyres and true indices differ initially (in 1967) by 6.7% but the values are identical by 1977. Also, the data in Table 12 show an interesting discrepancy between the growth rate in Direct Costing, 5.1%, versus the true growth rate, 5.7%. The Direct Costing methodology will underestimate the true growth rate when the relative force structure between the U.S. and the Soviet Union differed more in the past than in the present.[8] Such is generally the

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curve u_2 in Figure 22 with the lowest cost. This implies that we must investigate only the structure of the utility function for the U.S. planner. For this reason, we impute a utility function only to the U.S. planner and,obviously, this imputation must be based on observed U.S. prices and quantities.

[7]Tonnage rather than actual ship numbers were used in order, at least to some extent, to "Americanize" the data. The rationale was that, for example, the U.S. planner will prefer one U.S. destroyer to one SU destroyer. Since a U.S. destroyer weighs more than a SU destroyer, measuring in terms of tons is a step in the right direction. That is, it is assumed that one U.S. destroyer ton and one SU destroyer ton are indistinguishable.

[8]Since the observations are taken as exact, the growth rates were calculated using the standard compounded annual growth procedure

TABLE 12

DIRECT COSTING VERSUS TRUE VALUES

Year	Direct Costing Value of SU Force	Laspeyres (L) Index	True Dollar Value of SU Force	True (T) Index
1967	8,906	.286	8,345	.268
1968	9,311	.297	8,684	.277
1969	10,066	.328	9,391	.306
1970	10,349	.382	9,753	.360
1971	11,090	.425	10,542	.404
1972	11,689	.452	11,146	.431
1973	11,729	.473	11,110	.448
1974	13,041	.585	12.372	.555
1975	13.423	.577	13,144	.565
1976	14,042	.614	13,951	.610
1977	14,587	.647	14,587	.647
Compounded Growth Rate[a]	5.1%	8.5%	5.7%	9.2%

[a]Compounded U.S. Growth Rate (i.e., $P^u X^u$ growth rate) = -3.2%.

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case when comparing U.S. and Soviet defense expenditures.

Although these results constitute only a modest pilot effort, they indicate the potential of this approach. Unfortunately, in order to apply this utility framework to the total U.S. and Soviet forces, a suitable "Americanized" data base must be constructed. That is, in each category a single U.S. unit must be indistinguishable from a single Soviet unit (U.S. perspective). Clearly, further research in this direction would be required. The following section on Quality Change and New Goods present several proposed theoretical and operational approaches to solve the problem.

The four indices, E_1 through E_4, could not be applied in the years 1967-1975 because the Soviet force contained no carriers in that period (the index values were either zero or infinity). The data for 1976 and 1977 are shown in Table 13.

TABLE 13

ALTERNATIVE INDEX VALUES--SHIPS

Year	E_1	E_2	E_3	E_4	L	T
1976	-.381	.477	.25	.464	.614	.610
1977	-.371	.502	.25	.482	.647	.647

The carriers were then eliminated and the model rerun using the remaining three ship types. The results appear in Table 14.

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instead of the curve fitting technique used in the alternative estimates. The results are nearly identical using either methodology, however.

TABLE 14

ALTERNATIVE INDEX VALUES (CARRIERS ELIMINATED)

Year	$p^u x^u$	Laspeyres (L) Index	$p^u x^*$	True (T) Index	E_1	E_2	E_3	E_4
1967	8,900	0.467	8,747	0.459	0.162	0.380	0.432	0.486
1968	9,306	0.483	9,229	0.479	0.201	0.396	0.450	0.497
1969	10,083	0.544	10.065	0.543	0.308	0.443	0.500	0.555
1970	10,334	0.633	10,334	0.633	0.492	0.515	0.602	0.633
1971	11,089	0.707	11,026	0.703	0.619	0.567	0.683	0.691
1972	11,680	0.739	11,601	0.734	0.666	0.593	0.716	0.713
1973	11,740	0.778	11,634	0.771	0.723	0.624	0.758	0.749
1974	13,030	0.980	12,857	0.967	0.937	0.768	0.939	0.938
1975	13,419	1.020	13,156	1.000	0.960	0.787	0.961	0.962
1976	13,704	1.017	13,421	0.996	0.962	0.786	0.963	0.963
1977	14,256	1.084	13,927	1.059	1,015	0.836	1.015	1.021

The elimination of the carriers leads to near parity of the two forces by 1974. Also, the indices E_3 and E_4 appear to provide useful information in conjunction with L in estimating a possible range for T. For example, whereas L always exceeds T (as it theoretically must) in these particular tests, E_3 consistently underestimated T. The index E_4 underestimates T when T is near unity (greater than 0.60) and overestimates T when T is less than 0.60.

The results of these studies on alternative indices suggest the viability of using alternative index forms for comparison with the Direct Costing (Laspeyres) form. Again, the alternative forms provide theoretically valid corrections for non-linearities in the underlying preference structure (utility function). However, these forms did not perform very well in comparison with the traditional Laspeyres form based on an implied Soviet utility function calculated from unclassified CIA data. One explanation for this is the essentially linear utility function estimated from the modified real data. In such a function there are no second order effects, resulting in an over-correction using the alternative forms.

A linear utility function implies that the planner is willing to trade off a fixed amount of one defense good for another, regardless of the number of each good he has. This constant marginal rate of substitution, obviously, does not hold in general for all quantities. Possible reasons for the linearity include aberations in the data and in the modifications necessary to declassify the specific numbers and the narrow quantity ranges over which the function was estimated.

The artificial data set is thought to provide a more general test of the index forms. The test was limited since only one form of the utility function was used to calculate the true index, but this form, convex to the origin, is more representative of general classes of utility functions than is the linear function. In this test, forms E_3 and E_4 appear to work quite well and, since they are the two alternative forms that have the greatest theoretical support (well defined properties and extensive documentation), it is recommended that these two forms be further analyzed for possible implementation. The main difficulty in such an undertaking would be in constructing a data base consistent between both countries. That is, forces must be aggregated (or disaggregated) in such a way that each country has the same force components.

Quality Changes and New Goods

Another index number problem develops if a good undergoes a quality change or if a new good is introduced. As an example, if even one U.S. defense good does not exist in the Soviet arsenal then the quantity relative X^u/X^s becomes infinite and its inverse, X^s/X^u, is zero. A similar problem exists if any good in the Soviet inventory does not exist in the U.S. arsenal. The theoretical result is that the index forms cannot be calculated directly. A related problem exists when an existing good undergoes a qualitative change.

Several operating procedures have been proposed to assign prices for goods which do not exist in one of the two countries or for goods

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which undergo changes. The results lack the theoretical rigor of basic index number theory but may be acceptable alternatives to the basic formulations. The adequacies of these methods is a function of both the techniques employed and the specifics of the actual application.

Fisher and Shell (1972) consider a qualitative improvement to be equivalent to a price reduction in that good. However, the adjustment is complicated since it depends on all prices and quantities and not simply on the physical characteristics of the quality change. It is assumed that the item substitution is a quality improvement expressed as an increased service to be gotten from the item and equivalent to a reduction in the price of only that item. For this method one must derive a coefficient, g, which is a constant, independent of all other prices, such that one unit of the new item, b, using a single quality criterion is equal to g units of the old item, a. That is, $P_b(t) = g \cdot P_a(t)$. Thus, the resulting index would be (Allen, 1975)

$$\frac{P_t}{P_{t-1}} = \frac{P_b(t)}{g P_a(t-1)} \cdot \tag{131}$$

For the case where quality is not considered to be directly measurable, Allen proposes that certain characteristics, z_1, z_2, ..., z_n, can be identified which are both measurable and correlated with the overall quality property. "g" then is the ratio of the characteristics possessed by a and by b. The characteristics, z, have an implied quality price at time, t, c(t) such that

$$P_a(t) = c(t)z_a, \quad P_b(t) = c(t)z_b \quad \text{and}$$

$$P_b(t)/P_a(t) = z_b/z_a = g.$$

The overall price at time t would be

$$P = c_0 + c_1 z_1 + c_2 z_2 + \dots + c_n z_n. \tag{132}$$

Subject to data availability, multiple regression techniques can be used to analyze a cross section of prices and characteristics at time t to estimate the quality prices, $c_0, c_1, \dots, c_n$. (Allen, 1975)

Fisher and Shell (1972) define a new good as one that is purchased in positive amounts during the current period but for which base period purchases were zero. The opposite is the case for disappearing goods.

The system is

> ...solved for y (the expenditure) after assigning to p_k (price in the base period) any value greater than the demand reservation price (the lowest price at which the demand for the kth good is zero) including the supply reservation price (the highest price at which supply of the kth good is zero) which in some sense is the price that consumers actually faced during the base period. (Fisher and Shell, 1972, p. 23)

The following ratios are equal in a perfectly competitive market:

1. Ratio of prices of two goods available on the market (purchasing power parity).

2. Ratio of marginal costs to the producer.

3. Ratio of marginal rates of substitution to the consumer.

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The first ratio is used when market prices exist in the same time frame for both goods in the substitution.

If the prices are not available then the relative price ratio, g (defined earlier) can be estimated from the supply side as the ratio of the marginal cost of the new item to that of the old item, whether or not this is consistent with consumer preferences in an imperfectly competitive market. Allen states that this, "Implies an equivalence between quality and production costs. Costs may overstate an improvement in quality by assuming as 'improvements' whatever costs more, irrespective of the consumer's views." (Allen, 1975, p. 254)

This last method should receive special attention since it is the basic form of the adjustments used by the CIA in their direct costing approach. The Agency recognizes both the limitation given by Allen and the problem of quantifying productivity changes which may accompany intertemporal quality changes. The next section will examine in considerably more detail the specifics of this previous CIA index number-deflator methodology. In addition, a revised methodology, designed to minimize certain theoretical and practical shortcomings of the existing methods, will be presented.

Price Indices Deflators for
Defense Products

The basis for this section is a memorandum prepared by James E. Steiner (1977) of the Military-Economic Analysis Center, Office of Strategic Research, Central Intelligence Agency.

The primary goal of the pragmatically oriented research by the CIA into index numbers for defense products "... is to construct a set of price indices (or deflators) which, when applied to current dollar series will yield constant price value of output series that reflect only changes in annual levels of real output." (Steiner, 1977, p. 2)

For standard industries a deflator, which is a weighted average of specific wholesale price indices (WPI), is developed by the Bureau of Labor Statistics (BLS). Four digit Standard Industrial Code (SIC) groupings are used to define the specified industry. The individual WPIs are based "on transaction price data for 'representative goods'." Since military products, due to their non-standard nature, do not meet this criterion, they are excluded from the WPIs. (Steiner, 1977, p. 2)

The basic problem, and the method used to resolve it, are explained in a Department of Commerce, Bureau of Economic Analysis (BEA) publication which states that,

> ...in instances where the output of an industry is complex, nonhomogeneous (as for many items of military equipment), it is difficult to define price and quantity of output ... in measurable terms. One must then resort to estimating the output price changes from the prices of materials and services used to make the equipment. (U.S. Department of Commerce, 1975, p. 21)

This, again, was the method used by the CIA in handling the problem of quality change and new goods. Steiner notes that the major assumption of this technique is that price changes for such products result only from changes in the cost of the material and labor inputs to the production process. There is no consideration for productivity or quality change.

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This cost input deflator is defined by the following relationship: (Steiner, 1977, p. 3)

$$\frac{D_i}{D_{i-1}} = \frac{L}{L+M}_i \quad \frac{W_i^1}{W_{i-1}^1} (m_i^1) + \frac{W_i^2}{W_{i-1}^2} (m_i^2)$$

$$+ \frac{M}{M+L}_i \times \sum_{j=1}^{n} \frac{P_i^j}{P_{i-1}^j} (s^j) \tag{133}$$

where

D_i the price deflator

L is the current value of labor input

M is the current value of material input

W is the wage rate for a given type of labor

m is the given year share of production workers (m^1) and all other employees (m^2) in total personnel costs

P is the WPI entry for a given material product group

S is the share of a given material in the total material inputs derived from the 1967 input-output table

subscripts denote time, superscripts denote type of material or labor.

Steiner presents two basic sources of bias in the above deflator. These are

(1) The index formulated in (Equation 133) implicitly assumes that the average quality of a labor hour in a given industry is homogeneous over time, and therefore any change in the price of labor (wage) is a pure price increase.

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(2) In addition, the exclusion of any refyrence to the industry's stock of capital, its rate of utilization, or its price or rate of return his further implications for the accuracy of the estimated deflator. Assuming an increasing capital/labor ratio over time, real output per manhour can be expected to increase, thereby exacerbating the bias (overstatement of price increase) in the deflator resulting from the use of an unadjusted index of hourly wages. The exclusion of a variable for capital also assumes that the unit cost of capital, weighted by its share in the total value of shipments, changes at the same rate as the deflator presented in (Equation 133) -- almost certainly an unwarranted assumption. (Steiner, 1977, p. 4)

An alternative form of the deflator presented as Equation 133 was then proposed. This formulation takes the above factors into account, after making allowances for defense industry specific data problems. The alternative form is

$$\frac{Dl_i}{Dl_{i-1}} = \left[(\frac{P}{0})_i \times \frac{P_i^k}{P_{i-1}^k} \right] + \left[(\frac{L}{0})_i \times \left(\frac{W*_i^1}{W*_{i-1}^1} (m_i^1) + \frac{W*_i^2}{W*_{i-1}^2} (m_i^2) \right) \right]$$

$$+ \left[(\frac{M}{0})_i \times \sum_{j=1}^{n} \left(\frac{P_i^j}{P_{i-1}^j} (S^j) \right) \right] \qquad (134)$$

where

P^k is the deflator for GPDI

$W*$ is the wage series adjusted for productivity

0 is the total value of output

All other terms are as defined for Equation 133. (Steiner, 1977, p. 6)

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In this formulation the long-run trend (1950-1975) in the BLS Private, Non-Farm Output Per Man-Hour Series is used to discount the industry specific wage series for productivity growth.

The original deflator in Equation 133 considers only weighted materials and labor (unadjusted for productivity change) indices. The proposed alternative form is a weighted capital, materials, and labor (adjusted for productivity) cost deflator.

Steiner performed a series of regression analyses using the deflators defined by Equations 133 and 134 against the BLS industrial-sector price indices (ISPI) for five industries. These industries had both products similar to those of defense and similar capital-labor-material share weights. The ISPI values were the standard for the comparison.

The results of this empirical study were:

(1) The original deflator showed statistically significant differences from the ISPI values.

(2) The alternative deflator was found to be a statistically adequate proxy for the ISPI.

(3) The original deflator for the output of defense-oriented industries overstates the growth in prices for such products. This implies an understatement of growth or an overstatement of decline in the real output of defense industries.

(4) The unweighted average overstatement of the growth rate in prices by the original deflator was almost 30 percent. (Steiner, 1977, p. 11)

The CIA is currently in the process of transitioning to the new deflator for estimates of U.S. and Soviet defense activity levels.

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CHAPTER VII

PRODUCTION — THEORETIC INDICES

The application of various theoretical approaches of index number theory to the problem of estimating Soviet defense expenditures has been guided by one overriding objective: to better understand the meaning and consequences of cross-country and intertemporal differences in defense spending from the perspective of the decision maker. No single index number can convey meaningful information fo all the legitimate purposes for which the decision maker may seek such information. The proper form of the index relationship thus must consider the objectives of the user and the underlying characteristics of the potential index forms. Our proposed index forms are designed to provide the decision maker such flexibility.

Any juxtaposition of defense spending between the United States and the Soviet Union has as an underlying objective the comparison of changes in military capability. A second major objective is to compare resources employed to support the defense establishment.

The proposed utility based indices offer a second order approximation to what can be very loosely construed as a measure of our perceptions of the difference in capability attained by defense spending in the two countries. These indices explicitly consider the proposition that if one was given the capability to produce the exact weapons mix

actually purchased by the Soviet Union, but at our relative prices, one would not choose to produce that mix. It has been shown that when the relative price structure differs between the U.S. and the Soviet Union, the U.S. would be indifferent between the Soviet weapons mix and another mix which cost less in terms of U.S. prices. The lowest cost mix which provides the same level of preference (or loosely construed "capability") as does the actual Soviet mix is the basis of the "true" index. Our proposed forms provide a second order approximation to this unknown "true" index.

Albeit useful as a proxy for changes in "capability" these index forms only weakly provide a comparison of the productive capacity employed by each country in the manufacture of military hardware. The following proposed index form is based on production theory without reference to any underlying preference structure. It concentrates on the resources employed and the technology of the production process. As such, it provides a completely different measure of comparison than that obtained by either the present indices or those forms which were previously developed.

First, we will set a basic algebraic framework for the production based indices, both in general functional form and for a Cobb-Douglas production function. This will lead into the graphical analysis which clearly reflects the elements of the proposed approach.

The computations involved in the algebraic development can be simplified considerably without compromising the purposes of our illustration by only considering a two sector model with two factors of production, capital and labor. This rather straightforward development

is based on the work of Uzawa (1963) and Fisher and Shell (1972).

We assume that the single output from each of the sectors follows the functional form

$$Y_i = F_i(K_i, L_i), \qquad i = a,c \qquad (135)$$

where

Y_i is the quantity of the output good (Y_c = value of conventional armament and Y_a = value of advanced armament).

K_i is the amount of capital employed in the production process for good (i).

L_i is the amount of labor employed in the production process for good (i).

F_i is considered to be a twice continuously differentiable production function for good (i).

The total value of defense expenditures (measured in terms of units of conventional armament) is given by

$$Y = Y_c + p Y_a \qquad (136)$$

where

p is the price of advanced in terms of conventional armament.

For the case of fully employed factors whose supply is perfectly inelastic,

$$K = K_a + K_c \qquad (137)$$
$$L = L_a + L_c. \qquad (138)$$

If factors are mobile and efficiently allocated, the wage rate for labor, w is given by

$$w = \partial F_c/\partial L_c = p \; \partial F_a/\partial L_a$$

and the rental rate of capital is given by

$$r = \partial F_c/\partial K_c = p \; \partial F_a/\partial L_a.$$

We assume that the production functions exhibit constant returns to scale and define

$$K = K/L, \; y = Y/1, \; W = w/r$$

and

$$K_i = K_i/L_i, \; y_i = Y_i/L_i, \; \text{and} \; 1_i + L_i/L, \; i = a,c.$$

Equation (135) can then be rewritten as

$$y_i = 1_i \; f_i(k_i) \qquad\qquad i = a,c \qquad\qquad (139)$$

where

$$f_i(k_i) = F_i(k_i,1).$$

Under our assumptions $f_i(\cdot)$ is twice continuously differentiable and further assuming that

$$f_i(k_i) > 0, \; f'_i(k_i) > 0, \; \text{and}$$
$$f'_i(k_i) < 0 \; \text{for} \; 0 < K_i < \infty$$

then

$$w = f_i(k_i)/f'_i(k_i) \qquad\qquad i = a,c \qquad\qquad (140)$$
$$p = f'_c(k_c)/f'_a(k_a) \qquad\qquad\qquad (141)$$
$$y = y_c + p \; y_a \qquad\qquad\qquad (142)$$

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$$y_a = f_a(k_a) \frac{k_c - k}{k_c - k_a} \qquad (143)$$

$$y_c = f_c(k_c) \frac{k - k_a}{k_c - k_a} \qquad (144)$$

and from the above definition, $Y_i = y_i L_i$.

The equilibrium production of advanced and conventional armament can thus be determined given the total stock of capital and labor employed in production process. Equations (143) and (144) can be used to map a production possibilities frontier (PPF) which shows the maximum production of conventional and advanced armament which can be produced, given the available stock of capital and labor. Each point on the PPF corresponds to a different capital/labor ratio.

Cobb-Douglas Production Function[1]

The previously derived functional relationships will now be applied to production functions of the Cobb-Douglas form where

$$Y_i = K_i^{\alpha_i} L_i^{1-\alpha_i} \qquad (145)$$

Assuming all output is exhausted by payments to the factors,

$$Y_i = wL_i + rK_i \qquad i = a,c. \qquad (146)$$

One can formulate a cost minimization problem subject to the production function constraint and form a Lagrangian

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[1] The validity of the model does not depend on the assumed form of the production function. The empirical validity of the Cobb-Douglas form was shown in our burden analysis. For arguments favoring the use of a CES (constant elasticity of substitution) function see Weitzman, 1970.

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$$L = wL_i + rK_i - \lambda(K_i^{\alpha_i} L_i^{1-\alpha_i} - Y_i) \tag{147}$$

which has first order maximization conditions

$$\partial L/\partial L_i = w - \lambda(1-\alpha_i) K_i^{\alpha_i} L_i^{-\alpha_i} = 0 \tag{148}$$

$$\partial L/\partial K_i = r - \lambda \, \alpha_i \, K_i^{\alpha_i-1} L_i^{1-\alpha_i} = 0. \tag{149}$$

Dividing the solution of equation (148) by that of equation (149) gives

$$w/r = \frac{1-\alpha_i}{\alpha_i} \left\{\frac{K_i}{L_i}\right\}. \tag{150}$$

Multiplying both sides of equation (145) by $1/L_i$ gives

$$y_i = (K_i/L_i)^{\alpha_i} \tag{151}$$

$$= \left(\frac{\alpha_i}{1-\alpha_i}\right) \frac{w}{r}^{\alpha_i}. \tag{152}$$

p, the price of advanced armament in terms of conventional armament, can then be shown to be equal to

$$p = \frac{w}{r}^{\alpha_c-\alpha_c} \frac{(1-\alpha_c)^{1-\alpha_c} \alpha_c^{\alpha_c}}{(1-\alpha_a)^{1-\alpha_a} \alpha_a^{\alpha_a}} . \tag{153}$$

The output of conventional armament per unit of labor input is given by

$$y_c = (k_c)^{\alpha_c} \left(\frac{k - k_a}{k_c - k_a}\right). \tag{154}$$

The output of advanced armament per unit of labor input is similarly given by

$$y_a = (k_a)^{\alpha_a} \left(\frac{k_c - k}{k_c - k_a}\right). \tag{155}$$

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As mentioned in the general development, given the total stock of capital and labor, the above relationships can be used to map the PPF by varying the capital/labor ratio. The value of output is maximized when the price, p, is given by equation (153).

This development is meant to show the form of the relationships which can be used to obtain numerical estimates of the PPF and the value of output at the operating point. The use of these relationships to form production based indices is most easily shown by a graphical analysis, which is the subject of the next section.

Graphical Analysis

The set of PPFs form the production possibility map (PPM). This map shows the efficient combinations of quantities of conventional and advanced armament (in the present example) that correspond to different factor endowments, applied in different ratios (i.e., allowing K and L to vary as well as the k_i's).

If all the production functions exhibit constant returns (as does the Cobb-Douglas function) the functions will be homogeneous of degree one in both outputs and the inputs i.e., the PPM will be homothetic. It can be shown that the PPfs will always be either linear or convex to the origin. The general shape of the PPF can then be depicted as shown in Figure 23.

The oeprating point (A) is defined by the slope of the PPF being equal to the negative of the price of advanced in terms of conventional armament, p. The intercept of the tangent on the vertical axis gives

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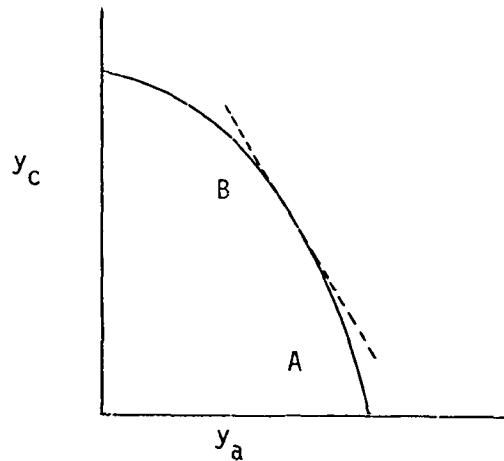
Figure 23

PRODUCTION POSSIBILITIES FROINTER

the value of output in terms of conventional armament. Conversely, the
horizontal axis intercept gives the value of output in terms of advanced
armament.

Each point on the PPF corresponds to a unique capital/labor
ratio (and wage/rental ratio). As the price relative changes, the
value of output measured in either terms of conventional or advanced
armaments will likewise change.

For example, if the price relative decreased such that a new
operating point was established at (B), the value of output measured in
terms of conventional goods would decline. However, the value of output
measured in terms of advanced armament would increase. Such movements
result solely from changes in the terms of trade between conventional
and advanced armaments. Such changes will be considered to be pure
price phenomena with real output remaining constant. Nominal output

(measured by the axis intercepts) will, of course, change to reflect the price changes.

PPFs can be drawn for both the U.S. and the Soviet Union. One need not assume that the production functions for both countries follow the same form for each type of output good, or that the parameters of such functions are the same. If the production functions exhibit constant returns and do have the same parameters, then the PPFs of the two countries would be homothetic. For many defense goods this may be an unrealistic assumption.

Figure 24 depicts the case where the PPF between the U.S. and the Soviet Union are considerably different. Despite the apparent complexity of the graph, it can be used to show, in a straightforward manner, the essence of several index forms.

In Figure 24 the U.S. is assumed to be operating at X^U on its PPF, P_1. The total value at the U.S. price relative is given as D_0. Likewise, the Soviet Union is assumed to be operating at point X^S with its total value given as R_0. In general, as in our case, $P^U \neq P^S$. If we assume that the compositions of the output goods are identical, then the PPFs for both countries can be drawn on the same graph.

The conventional method for estimating the dollar costs of Soviet defense expenditures is to apply the U.S. prices to the equivalent Soviet goods. This is depcited as the budget line D_1 drawn through X^S with a slope equal to that of D_0. The ratio

$$\frac{x_c^S + p^U x_a^S}{x_c^U + p^U x_a^U} = \frac{D_1}{D_0} \tag{156}$$

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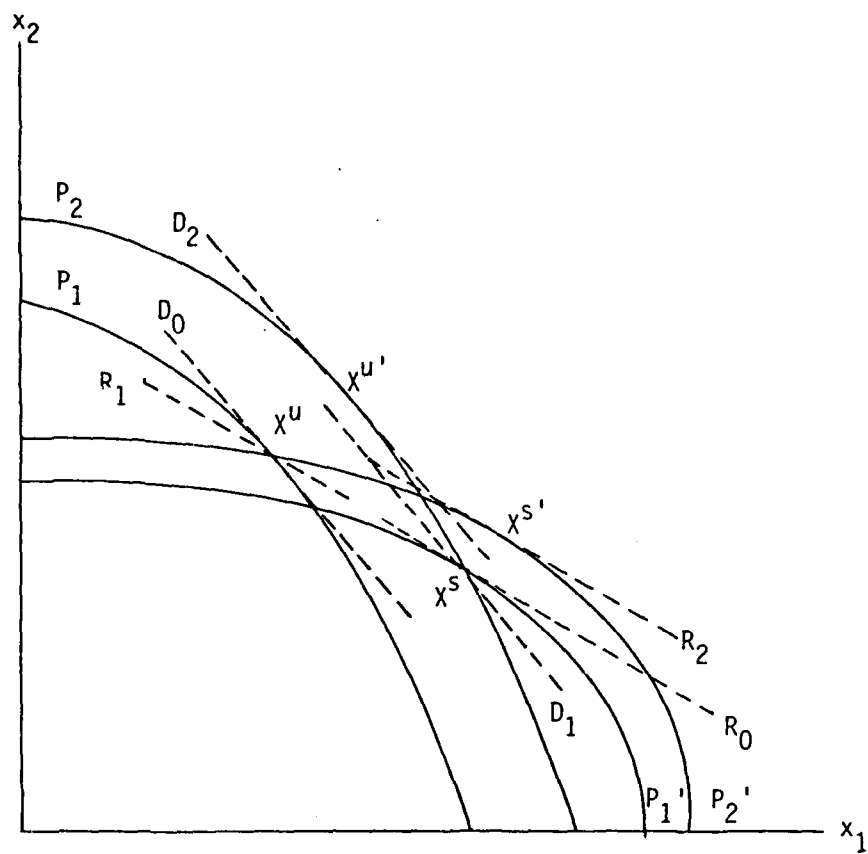
FIGURE 24

Production Index Relationships

corresponds to the conventional (similar to that calculated by the CIA) index of Soviet defense expenditures compared to U.S. expenditures, in terms of U.S. price relatives.

At this point it would be of some value to analyze the meaning and implication of the conventional index form from a production viewpoint. By applying U.S. prices to Soviet quantities, we are assuming that the U.S. could produce the Soviet quantity mix, but in doing so would face U.S. prices. For the U.S. to both be able to produce and to prefer this Soviet mix one must implicitly assume that it is feasible to construct a U.S. PPF through the point X^S with a slope equal to the U.S. price relative. The shape of this PPF does not necessarily have to correspond precisely to that of the Soviet PPF over the entire feasible region. It is only necessary that the curve pass through the point X^S with a slope equal to $(-p)$. For this example, given the production functions for the two sector model one can, at least theoretically, vary the total supply of input factors and their division between conventional and advanced armament in an attempt to produce such a tangency solution. In general, such a solution will not be possible without allowing the coefficients of the production functions to vary.

What this analysis shows is that although the U.S. may be capable of producing the Soviet weapons mix, to do so would not, in general, result in efficient production being located along the PPF. The conventional solution must then represent a non-optimal allocation of resources between conventional and advanced armament.

One possible solution to this problem would consist of a homothetic expansion of the input factors so that a feasible U.S. PPF does pass through the point X^s. Since at this point the U.S. price relative is not tangent to the new PPF (P_2), the budget line, D_1, does not represent the maximum value of output capable of being produced, given U.S. technology and the resources necessary for the U.S. to produce the Soviet weapons mix.

For such maximization to occur, the U.S. would choose to shift production (always along the PPF) to the point $X^{u'}$ where the U.S. price relative produces the optimizing tangency solution. The value of output at this point, D_2, would then represent the value of output to the U.S. attainable by expanding output by proportional increases in the factors of production. Such an expansion includes as a feasible production point the Soviet quantity mix, X^s, but allows the mix to vary, keeping total resources constant, to optimize production according to strictly U.S. production functions and prices.

In the utility index form we sought to minimize the cost of weapons while maintaining the same level of preference we perceived attained by the Soviet weapons mix. Conversely, the production index maximizes the value of total production. This maximization uses U.S. production technology and prices and is thus an inherently "Americanized" dollar cost comparison. The question answered by this new index is, "By what percentage must the resources allocated to defense production by increased (reduced) proportionately to produce the Soviet weapons mix?" The ratio, D_2/D_0, provides such a measure in terms of U.S. production capability and prices. For homothetic production

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functions points X^u and $X^{u'}$ would be located along a ray from the origin.

A homothetic expansion of the production function is not the only meaningful method of adjusting the U.S. PPF to produce a new PPF which passes through the point X^s. Indeed, there are an infinite number of possible adjustments which could produce a PPF through that point. By allowing the operating point to move along the PPF to a tangency point using U.S. price relatives, different estimates of the dollar value of Soviet defense spending will be produced. The value of permitting such multiple solutions to enter into the analysis is that different, and potentially quite useful, questions can now be answered.

Using the production-theoretic form of analysis we can provide meaningful answers to questions such as, "How much must the capital stock (labor employed) be expanded, holding other factors constant, to produce the Soviet mix? If employment in defense industries were increasing by say 10% a year, by what percentage must we increase the capital stock to produce the same dollar value as projected for Soviet defense production in 1985?"

The value of these index forms, then, is the additional flexibility they give to the decision maker in analyzing the relative U.S./Soviet expenditures levels and their implications to their re-spective economies.

The same type of analysis can be performed interchanging the roles of the U.S. and the Soviet Union. In our example the Soviets would have to expand the value of defense expenditures to point $X^{s'}$ to produce optimally along their PPF which passes through the U.S. weapons

mix. The value of R_2 would then be a Soviet estimate in rubles of the value of U.S. defense spending.

The production possibilities maps for the U.S. and the Soviet Union were drawn with considerably different shapes to illustrate an important potential result. If the Soviet weapons mix lies outside the PPF that the U.S. is currently operating on, then the production-theoretic index will always show the value of Soviet expenditures exceeding that of the U.S., using U.S. prices. Similarly for the Soviets, if the U.S. weapons mix lies outside the present Soviet PPF the ruble production index will always show the U.S. to be in a domi-nant position. It is possible, as in our example, for the Soviet value of defense expenditures to exceed that of the U.S. in dollar terms and for the U.S. value to exceed that of the Soviets in ruble terms. Rather than being a discrepancy in the methodology, this simply illus-trates that the two indices answer different questions.

In a practical sense, analysis of Soviet and U.S. production technologies indicate that the production functions are generally quite similar and that the direction of the inequality is the same for both the ruble and the dollar comparisons.

Although straightforward theoretically, significant problems occur when attempting to impliment production theoretic indices. Since it is based on production theory it can only be applied to production goods used in the defense establishment. However, the costs of such goods are a significant percentage of total defense spending. Additionally, the uncertainties of these cost estimates are often con-siderably greater than the uncertainty associated with estimates of the

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resources consumed by the appropriate industries and their production function parameters.

Straightforward techniques do exist for translating Soviet manpower costs into an estimated dollar form. By imputing a U.S. rank and support structure to the level of Soviet manpower one is partially performing the same shift which occurs in the production index methodology. That is, rather than just applying equivalent U.S. costs to the Soviet manpower ranks, one adjusts the rank structure to fit U.S. requirements. No attempt will be made here to define a new methodology for translating Soviet personnel costs to a dollar numeraire. The chapter on budgetary methodologies does highlight certain promising approaches.

Considerable work has been done and continues to be done on the problem of estimating the dollar costs of research, development, test and evaluation (RDT&E). The Lee approach of estimating the inputs to RDT&E enterprises appears most compatible with the proposed production-theoretic index method. The practical problems of implementing this approach must remain outside the scope of this study.

The final major cost category, operations and maintenance can benefit significantly from the estimation philosophy proposed. Basically, it is argued that dollar based estimates of Soviet defense spending should not blindly apply U.S. prices to U.S. quantities. The utility approach applies a second order approximation to preference considerations. The production-theoretic approach adjusts the dollar value of Soviet production to reflect U.S. technology and prices.

Similarly, the operations and maintenance costs should reflect U.S. practices and procedures. The dollar cost estimates of the CIA,

however, include an estimate of operating and maintaining Soviet equipment in a manner *as the Soviets do*. Using a Soviet philosophy and set of procedures, one can argue, is not compatible with the general purpose of dollar based estimates. To "Americanize" the Soviet defense effort so that a valid direct comparison with the U.S. can be made requires that U.S. operating procedures be applied.

The practical aspects of producing dollar estimates of operating and maintaining the dollar equivalent Soviet military establishment appears far less formidable than producing accurate cost estimates of arcane Soviet military equipment. In an era of life cycle costing and design to cost, the procedures for estimating operating and maintenance expenses have been highly developed, although their accuracy still may be questionable. Regardless, these expense categories should be calculated according to U.S. philosophies and procedures and the failure to do so severely compromises any dollar cost estimate.

So far it has been sketched out, in a very rough manner, a general technique of comparing the production of military hardware between the U.S. and the Soviet Union. Additionally, it has been shown that such an approach can be the cornerstone for providing a more "Americanized" estimate of total Soviet defense spending. The resources required to implement these techniques, especially to develop the data base, will be significant. It is believed, however, that the problems are not insurmountable and that the additional insights are worth the costs of the analysis.

One last point; the production-theoretic approach is fully
compatible with the model developed in the chapter on the burden of
defense expenditures. That chapter we sketched out the algebraic
solution assuming a constant supply of factor inputs as production
varied along the PPF. Such movement, however, does change the measured
cost of defense spending. In the burden study it was shown that as
defense spending changes, the supply of the factors of production
changes inversely. Allowing for such changes in the development of
the production-theoretic indices provides an additional complication,
but also the potential for increased accuracy.

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CHAPTER VIII

CONCLUSIONS

As long as military power remains a key element in a country's power equation, the decision makers must clearly understand the advantages and limitations of the available measures of that power and its comparison between countries. No methodology is ideal for all purposes. The appropriate measure is a function of both the characteristics of the methodologies and the specific objectives of the decision maker. Neither exists in isolation from the other.

This study analyzed the underlying assumptions of current estimation and comparison methodologies. These methodologies were found to be inappropriate for many purposes. Among the limitations are: (1) they do not provide any measure of perceived capability, (2) they provide only limited information as to the resource implications of defense spending, and (3) they provide inaccurate measures of the rate of growth of defense spending. These shortcomings are aggravated by inherent, unknown biases in their estimates and comparisons. As a result, the findings may be grossly in error and thus lead to inappropriate policy decisions.

The proposed burden model provides a new methodology for calculating the economic cost of defense expenditures and presents several options for measuring the burden of such spending on an

economy. A simple, correlative form of the model was developed and exercised to illustrate how defense spending is related to changes in macroeconomic variables. The preliminary results indicate significant biases in the current estimated rate of growth of Soviet defense expenditures. The full burden model could provide additional information as to these biases.

The tools of analysis are further expanded in the chapters on index number relationships. As in the burden analysis, no single index relationship is appropriate for all valid comparison objectives. This study rigorously defined the comparison properties of the current index forms and proposed new forms based on utility and production theory.

Hopefully, the new tools developed in this study will be of some assistance in helping the decision maker understand the objective and subjective nature of defense spending. At the very least, it should encourage the further development of estimation and comparison methodologies.

APPENDIX A

UNITED STATES JOINT DEFENSE PLANNING

This section describes the process and environment in which
U.S. defense planning takes place. The emphasis is on the Department
of Defense (DoD) level and the planning activities of the Joint Chiefs
of Staff (JCS). A knowledge of the process of developing U.S. defense
programs is an adjunct to the understanding of the U.S. military
budget. In addition, the dollar cost comparison between U.S. and
Soviet defense expenditures prepared by the Central Intelligence
Agency (CIA) is reported in terms of the general program categories and
definitions described in Tables   and . Much of the detail provided
in this section was obtained from military budget documents. (See U.S.
Air Force, 1977a; 1977b)

The results of JCS planning are presented in seven basic
documents:

JIEP   -- Joint Intelligence Estimate for Planning

JLREID -- Joint Long Range Estimate Intelligence Document

JLRSS   -- Joint Long Range Strategic Study

JSOP   -- Joint Strategic Objective Plan

JFM   -- Joint Force Memorandum

JSCP   -- Joint Strategic Capabilities Plan

JRDOD   -- Joint Research and Development Objectives Document.

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The JSOP, JFM, and JSCP represent the general area of strategy. The JIEP and the JLREID cover intelligence, with the JRDOD representing the Research, Development, Test, and Evaluation (RDT&E) area. These three basic areas for joint strategic planning will not be covered in more detail.

Joint Intelligence Estimates

The Joint Chiefs of Staff provide two joint intelligence estimates, the Joint Intelligence Estimate for Planning (JIEP), and the Joint Long Range Estimative Intelligence Document (JLREID). The JIEP provides the intelligence base for preparing the Joint Strategic Objective Plan (JSOP), the Joint Force Memorandum (JFM), the Joint Strategic Capabilities Plan (JSCP), and the mid-period estimate for the Joint Research and Development Objectives Document (JRDOD). The JLREID provides the intelligence base for the long range portion of the JRDOD and the Joint Long Range Strategic Study (JLRSS).

The JIEP is submitted yearly to the JCS for approval by December 1. It contains short and mid-term estimates concerning situations and developments throughout the world that could affect U.S. security interests. It includes:

> (1) A global appraisal with an estimate of the world situation and the nature of the military threat, (2) regional appraisals including estimates of the external and internal threats to countries of significance to the United States, and (3) estimates of the Warsaw Pact and Asian Communist military forces. (U.S. Air Force, 1977a, p. 13.

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The Defense Intelligence Agency prepares, maintains and updates the Joint Intelligence Estimate for Planning Supplement. This document contains significant intelligence changes that may occur in the interim between the annual publication of the JIEP.

The JLREID

> ...shall summarize factors and trends affecting world power relationships in the long range planning period, including an intelligence estimate of the likelihood and capabilities of important foreign nations to undertake courses of action which could materially affect the national interests of the United States. (U.S. Air Force, 1977a, p.13.

Joint Strategy Documents

The Joint Long Range Strategic Study (JLRSS) analyzes national objectives, policies and military constraints in light of national and international economic, political, social, technical, and military trends. The JLRSS provides the background from which more detailed studies can focus on a particular problem. It includes:

A. A strategic appraisal of the major political, ideological, military, socio-economic, and techno-scientific factors and trends which are expected to influence the world environment over the long term.

B. A consideration of the probable major world power groupings, including alternative power alignments, and a listing of possible conflict situations.

C. A broad description of the capabilities that the U.S. Armed Forces should possess in order to serve effectively as an instrument of national policy in the long range period.

D. A correlation of the anticipated U.S. military
   capabilities with major research and development
   (R&D) goals in terms of required long range
   operational capabilities. (U.S. Air Force,
   1977a, p. 14)

The Joint Strategic Objectives Plan (JSOP) provides the JCS
recommendations to the President, the National Security Council, and
the Secretary of Defense on both the military strategy and the force
structure required to attain the national security objectives of the
U.S. It also serves as the basis for planning by the unified and
specified commands.

Volume 1 of the JSOP is the Military Strategy and Force Plan-
ning Guidance. This document is the first input into the DoD Planning,
Programming, and Budgeting (PPBS) System. From a statement of the
national security objectives, this volume presents the resulting mili-
tary objectives, military appraisal of the international situation, and
strategy formulation guidance.

Volume II of the JSOP is the Analyses and Force Tabulations.
In it, the Five Year Defense Program (FYDP) is compared with the force
levels recommended in the JSOP. The military risks imposed by fiscal
constraints in the FYDP are analyzed as well as the capability of the
FYDP to support the recommended force levels. Additionally, recommended
force levels for selected allied and friendly countries are included as
a guide to military security assistance programs.

While the JSOP reflects basically a fiscally unconstrained set
of recommendations by the JCS, the Joint Force Memorandum (JFM) force

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levels and support recommendations are constrained by the Planning and
Programming Guidance Memorandum issued by the Secretary of Defense.
The JFM is a key background document for the military departments in
developing their Program Objective Memorandums (POMs). The JFM
includes an analysis by the JCS on the ability of the constrained force
levels to execute the strategy in Volume I of the JSOP, and the in-
herent risks associated with these force levels. (U.S. Air Force,
1977a)

The Joint Strategic Capabilities Plan (JSCP) provides overall
guidance to the unified and specified commands and the individual
Services for the accomplishment of their military tasks based on near
term constraints. Volume I of the JSCP--Concept, Tasks, and Planning
Guidance--sets forth the strategic concepts and assigns specific tasks.
Volume II--Forces--identifies the forces available for operational plan-
ning. A set of annexes to the JSCP prescribes planning guidance,
indicates capabilities, and assigns tasks withing certain explicit
functional areas.

Joint Research and Development Planning

After analyzing the intelligence estimates in the JIEP, JLREID
and other related documents, and the strategy, capabilities, and force
recommendations in the JSOP, the JCS prepares the Joint Research and
Development Objectives Document JRDOD). R&D related deficiencies are
identified and priorities are set among the resulting R&D objectives.
Current programs are analyzed with respect to their ability to overcome

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identified deficiencies. Each functional area is analyzed to identify

technological opportunities as well as the operational deficiencies.

TABLE 15

DOD FIVE-YEAR DEFENSE PROGRAM STRUCTURE

Program Definitions

Program 1 - Strategic Forces. Consists of Strategic Offensive, Strategic Defensive,and Civil Defense (as major subdivisions). Includes command, logistics, and support organizations identifiable and associated with these forces.

Program 2 - General Purpose Forces. Consists of combatant force-oriented program elements other than those in Program 1 including the command organizations associated with these forces, the logistics organizations organic to these forces, and the related support units which are deployed or deployable as constituent parts of military or naval forces and field organizations.

Program 3 - Intelligence and Communications. Includes resources related primarily to centrally directed DoD objectives for intelligence and security, communications, and other mission-oriented functions such as Mapping, Charting and Geodesy, Weather Services, Oceanography, and Aerospace Rescue/Recovery.

Program 4 - Airlift/Sealift. Consists of airlift/sealift and other transportation organizations both industrially-funded (IF) and non-industrially-funded (NIF) when funded by the same organization which funds IF transportation. Includes command, logistics and support units organic to these organizations.

Program 5 - Guard and Reserve Forces. Consists of National Guard and Reserve training units. Elements are arranged in program order to facilitate the relating of the Guard and Reserve training forces to the active force structure.

Program 6 - Research and Development. Consists of all Research and Development activities which are not related to items approved for procurement and deployment. The R&D costs related to operational systems will be identified in appropriate program elements in the programs to which the weapons or support system may be identified.

Program 7 - Central Supply and Maintenance. Includes supply, maintenance and nonindustrially-funded transportation activities that are not organic to other program elements. Includes nondeployable supply depots and maintenance depots, both industrially-funded and non-industrially-funded.

Program 8 - Training, Medical, and Other General Personnel. Consists of training, medical, and other support activities associated with personnel. Excludes training specifically related and identified with another program element. Also excludes housing, subsistence, medical, recreational and similar costs and resources that are organic to a program element such as base operations.

Program 9 - Administration and Associated Activities. Consists of resources for the administrative support of departmental and major administrative headquarters, field commands, and administrative activities (not elsewhere accounted for), construction support activities and miscellaneous activities.

Program Ø - Support of Other Nations. Consists of program elements identified in the MAP program and those resources assigned to program elements related to the Military Assistance Program or supporting the Military Assistance Program.

TABLE 16

DEFENSE PLANNING AND PROGRAMMING CATEGORIES (DPPC)

OSD DPPCs are aggregates of program elements. The aggregations
are different from the ten major program aggregations of the DoD Pro-
gram Structure. Listed below are the categories in which the program
elements are to be summarized for PPBS purposes.

1. Strategic Offensive Forces
2. Strategic Defensive Forces
3. Strategic Control and Surveillance Forces
4. Tactical Air Force
5. Mobility Forces
6. Intelligence
7. Centrally Managed Communications
8. Research and Development
9. Support to Other Nations
10. Geophysical Activities
11. Mission Support Forces (MSF) - Base Operating Support
12. MSF - Force Support Training
13. MSF - Management Headquarters
14. Central Support Forces (CSF) - Base Operating Support
15. CSF - Medical Support
16. CSF - Personnel Support
17. CSF - Individual Training
18. CSF - Logistics
19. CSF - Central Support Activities
20. CSF - Management Headquarters
21. CSF - Federal Agency Support

22. Individuals
23. Miscellaneous

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APPENDIX B

BUDGETARY REVIEW ORGANIZATIONS

This section briefly describes the major departments and organizations involved in the U.S. defense budgetary process and their roles and responsibilities. For the sake of brevity only the major organizations in the Office of the Secretary of Defense (OSD), the Office of Management and Budget, and related organizations in both the Executive Office of the President and Congress will be discussed.

After each individual service prepares its budget estimates, the Secretary of each service formally submits these estimates to the Office of the Secretary of Defense/Comptroller (OSD/C). (U.S. Air Force, 1977a) Figure 25 depicts the organizational structure of the OSD/C showing that the Budget Directorates have the same titles as do the appropriation categories passed by Congress. (Steiner, 1976)

Steiner points out that because of institutional and fiscal pressures and constraints OSD/C's role far exceeds that of an accountant. (Steiner, 1976) Crecine (1970, p. 48) states that,

> Because fiscal constraints ultimately must be applied and because such constraints are not built into the earlier phases of the process, the budget review conducted by the Defense Comptroller's Office assumes the dominant role in determining the appropriations bill and in making broad DoD resource allocations decisions.
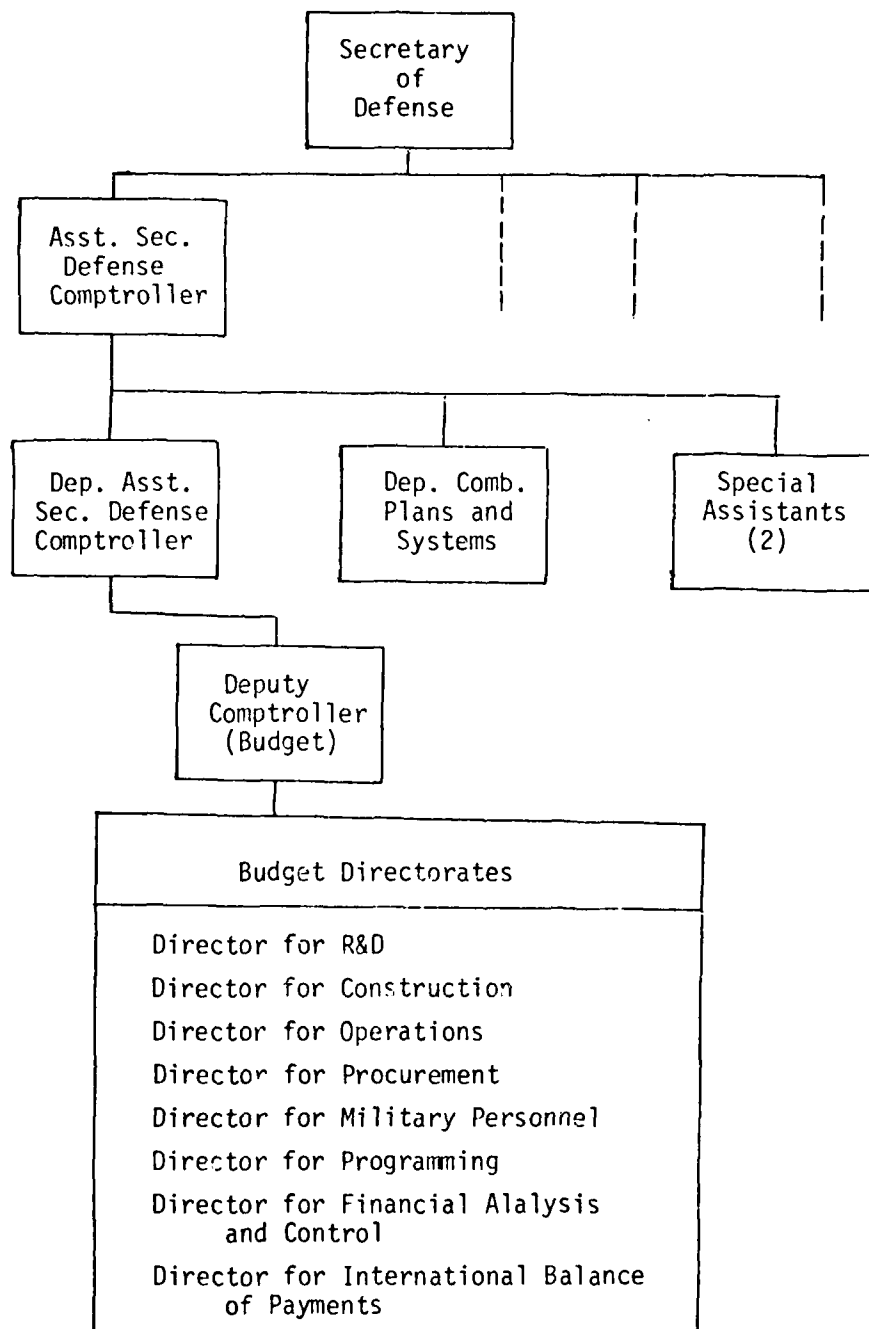
FIGURE 25

Organization of Deputy Comptroller's (Budget) Office

During the Budgetary review process in the Department of Defense the individual services may submit reclamas to changes tentatively made by OSD through Program Change Requests (PCR). The binding decisions are then made by the Secretary of Defense in the Program Change Decisions (PCD).

While the individual services prepare their budgetary estimates, the staffs of OSD and the Office of Management and Budget (OMB) also review defense objectives and requirements. Following a joint review, the Secretary of Defense submits his formal recommendation to the OMB.

The Office of Management and Budget is a staff organization in the Executive Office of the President. The primary functions carried out by OMB under the direction of the President are:

1. To assist the President in the preparation of the budget and the formulation of the fiscal program of the Government.

2. To supervise and control budget execution.

3. To evaluate the performance of Federal programs and to serve as a catalyst in the effort to improve interagency cooperation and coordination.

4. To assist the President by coordinating departmental advice on proposed legislation and by recommending Presidential action on legislation enacted by Congress.

5. To assist the President in his effort to achieve effective government by developing and implementing improved organizational structures and management processes in the executive branch.

6. To assist in the preparation and clearance of
   proposed Executive orders and proclamations.

7. To promote the improvement and coordination of
   Federal statistical services and to provide
   leadership in the development of new informa-
   tion systems.

8. To keep the President advised of the progress
   of activities by agencies with respect to work
   proposed, work actually initiated, and work
   completed. (U.S. Air Force, 1977a)

The National Security Division of the OMB has the primary

responsibility over budget proposals within the Department of Defense.

> The Division reviews long-range programs and pre-
> pares fiscal projections based on these programs. It
> conducts special analyses relating to problem areas of
> these agencies, emphasizing areas of common interest
> among them with a view toward improvements in coordina-
> tion, program effectiveness, economy of operation, and
> utilization of resources. (U.S. Air Force, 1977a, p. 86)

Figure 26 depicts the organizational structure of the National

Security Division of the Office of Management and Budget.

After the military departments and separate Defense Agencies

submit their budget estimates to OSD, OMB, and Defense Department staffs

conduct a joint review of the proposals. Among the areas covered in

this review are "...forces to be supported, plans for deployment, pro-

posed levels of operations, personnel strengths, production lead time

factors, inventory levels, etc." (U.S. Air Force, 1977a, p. 87) The

joint review minimizes the duplication of effort and wasted time which

would occur with separate reviews. A series of alternatives--the Pro-

gram Budget Decisions (PBD)--are then presented to the Secretary of

Defense.
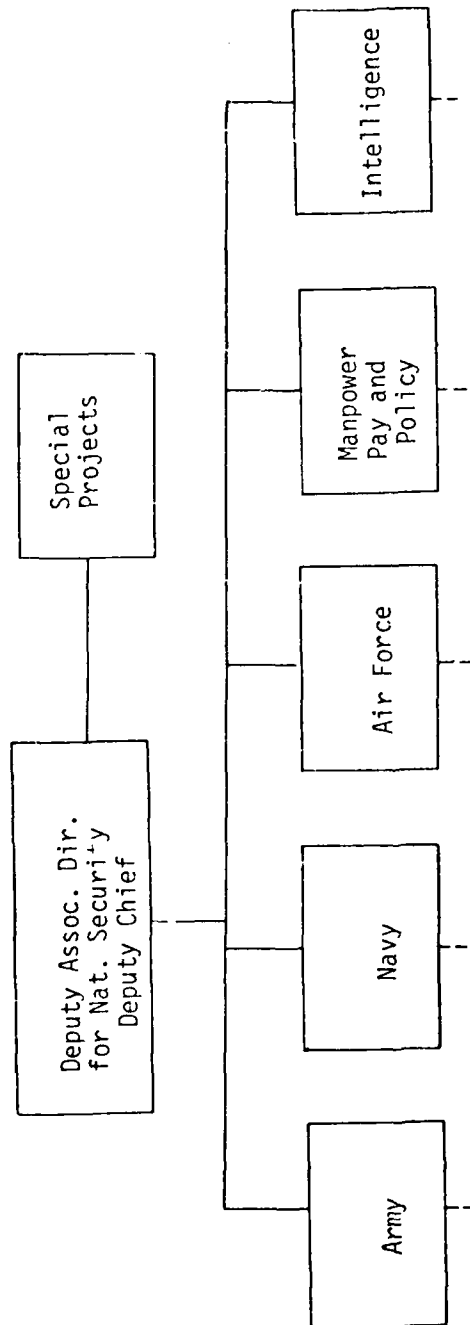
FIGURE 26

National Security Division (OMB)

A summary of the results of the review is presented to the Director of OMB who then meets with the Secretary of Defense in an attempt to resolve any differences. The recommendations of the Director and the Secretary are forwarded to the President, who makes the decisions on those items which cannot be resolved.

After the final Presidential determinations, budget estimates for executive, legislative, and judicial agencies, analyses of potential revenues, and supporting documentation are printed and bound for presentation to Congress as the *Budget of the United States Government.*

The House Committee on Appropriations' Department of Defense Subcommittee first receives the defense budget for congressional consideration. After a lengthy series of hearings the Subcommittee drafts an Appropriation Bill for consideration by the full Committee. After further debate and revision the Committee forwards the bill to the floor of the House of Representatives for their consideration.

After House approval, the Senate conducts a similar review through the Committee of Appropriations and its Department of Defense Subcommittee. Discrepancies between the House and the Senate passed versions of the Defense Appropriations Bill may finally be resolved through Conference Action before being finally approved by both houses of Congress and sent to the President for his signature. (U.S. Air Force, 1977a)

The following table presents the current and constant U.S. defense spending series for the period 1960-1979 (est.). Growth rates for the overall period and selected subperiods are also included. The

subperiods were selected to enhance comparability with similar sub-
periods calculated for Soviet defense spending estimates. For the
method used to calculate the growth rates, see the chapter on the
Alternative Methodology.

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TABLE 17

UNITED STATES NATIONAL DEFENSE EXPENDITURES

Year	Current ($MM)	Constant ($MM)[b]
1960	44.5	75.3
1961	47.0	78.3
1962	51.1	82.7
1963	50.3	79.5
1964	49.0	75.6
1965	49.4	73.7
1966	60.3	86.0
1967	71.5	98.5
1968	76.9	100.7
1969	76.3	95.4
1970	73.5	85.1
1971	70.2	75.8
1972	73.5	73.5
1973	73.5	69.5
1974	77.0	66.4
1975	83.9	65.8
1976	86.8	64.4
1977	94.3	65.7
1978[a]	106.0	69.2
1979[a]	115.8	70.5
Overall $\bar{g}$	5.98%	-1.19%
66-75 $\bar{g}$	1.90%	-4.69%
66-70 $\bar{g}$	4.72%	-0.53%
70-75 $\bar{g}$	2.71%	-4.85%

(Growth rates are fitted trends)

SOURCE: Council of Economic Advisors, Economic Report of the President, (Washington, D. C., January 1978).

[a]Estimated.

[b]Deflated by Implicit Price Deflator for Government Purchases of Goods and Services (Table B-3, Economic Report of the President, (Washington, D. C., January 1978).

APPENDIX C

THE SOVIET DEFENSE BUDGET PROCESS[1]

The totality of the Soviet defense budget consists of a single line entry. This lack of official information is also characteristic of present knowledge of the budgetary process which takes place in the Soviet Union. However, an attempt at juxtaposing Soviet and U.S. military spending and related organizational processes would be incomplete without at least a sketch of what one presupposes occurs in forming the Soviet budget.

According to Steiner (1976), the institutional process encompasses the formulation of annual and long-range budget proposals by the Ministry of Defense. A "defense industries committee" reviews the proposals prior to submittal to the Politburo which has (at least unofficially) final approval authority. The Central Committee approves the decisions of the Politburo.

The Military Services

The uniformed services of the Soviet Union are divided into the ground forces, navy, air forces, strategic rocket forces, and the air defense forces, all under the operational control of the Ministry of Defense.

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[1]This section relies heavily on Steiner (1976) and Warner (1973).

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The leadership echelons of the Ministry of Defense (MOD) are
comprised primarily of military personnel. This structural character-
istic leads Steiner to conclude that inter-service bargaining plays a
larger role in the MOD budgetary process than it does within the U.S.
Department of Defense. (Steiner, 1976) However, as career military
men, the leadership of the Soviet MOD can be expected to more strongly
support an expanded military program than would be the comparable U.S.
civilian leadership.

Defense Industries Committee

This committee, described as an:

> ...inter-agency commission or committee including
> representatives from the Ministry of Defense, the
> Defense production ministries, economic planning
> organizations and the Ministry of Finance, is
> charged with monitoring, coordinating, and
> directing defense-related research, development
> and production. (Warner, 1973, p. 31)

Steiner (1976) compares this organization to the U.S. Office of Manage-
ment and Budget. Within this committee are two major protagonist
schools of thought concerning defense spending. The MOD and defense
industries can be expected to favor expanded military expenditures with
the Ministry of Finance and economic planning organizations likely
favoring reduced spending. Steiner (1976) hypothesizes that this
committee also exerts budgetary control over RDT&E and procurement
proposals. As a minimum this group performs a program's analysis and
evaluation function.

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The Politburo

As far as the budgetary process is concerned, the Soviet Politburo functions as a combined legislature and executive department. It is here that the final decisions are made concerning the allocation of resources to military and vicilian programs. The Politburo has assumed a greater autonomy in the decision making process with the reduction of power of the Communist Party/Soviet Government leaders. (Steiner, 1976)

Defense Industries

Steiner (1976, p. 101) lists the following seven defense production industries which "together with a network of related research and development agencies, constitute a defense industrial comples."

1. Ministry of Defense Industry
2. Ministry of Aviation Industry
3. Ministry of Shipbuilding Industry
4. Ministry of Electronic Industry
5. Ministry of General Machine Building
6. Ministry of Medium Machine Building
7. Ministry of Machine Building.

According to Steiner, (1976, p. 102), "...these defense industrial enterprises are wholly owned and operated by the government, and the industrialists who head them up have a direct voice in the determination of the volume of annual production." The relative power of these defense ministries and their support for specific military services and programs may exert a strong influence on the pattern of military budget allocations.

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APPENDIX D

SOVIET STATISTICS

The accuracy of the aggregated data used in the proposed model depends directly on the accuracy of the primary data and how these data are manipulated statistically. Considerable evidence exists which shows there is a positive error in the reporting of basic output data. The major reasons for this overstatement are (1) political pressures to meet the goals of the economic plan and (2) financial pressure on the managers and workers, whose compensation is often a function of output. (Nove, 1974)

Unfortunately, the magnitude of the overstatement is unknown. The Soviets publish no information on it, and it is not calculable using Western sources of information. To the extent that such over-statements are consistent, they will have little effect on the rates of change of the basic statistics.

In an indictment of Soviet statistical procedures, Nove argues that the definitions of accounts are not clearly explained. They are ambiguous to begin with, and they change without notice. Furthermore, many different kinds of goods may be aggregated (by an often unspecified methodology) under a single heterogeneous category for statistical convenience. Thus, one cannot be sure of what meaning to attach to Soviet statistics. (Nove, 1974)

Furthermore, it is often the case that when a calculation is performed, there is more than one plausible method of calculation (usually the one with the largest result is chosen) from among the possible alternatives. Thus, directors and local officials tend to calculate output by whatever method enables them to report a large increase. The results of such calculations may be plausibly defensible, but they are not likely to be the most realistic results possible. The statistics thus produced are both confusing and suspect.

However, Nove (1976) believes those involved with forming the statistics do not deliberately report figures which they know to be false. The statistics can be distorted by (1) omitting data altogether and (2) by combining the data in such a way that the resulting statistics are misleading.

Despite these negative aspects of Soviet statistics, Nove concludes that, while they may be far from being completely reliable, the published figures are usually as accurate as the statistical agencies can make them. Production statistics (figures on units of output as opposed to index numbers) reported by Soviet sources are generally those used by planners. The Soviet Union does not keep a double set of books. The accuracy of Soviet statistics has improved considerably since Stalin, and it is still improving. (Nove, 1974)

A major problem in comparing the outputs of the Soviet and the U.S. economies arises from differences in their basic measures of the national income. The Soviets measure such income in terms of a net

material product (NMP). NMP is the value of tangible material output

net of depreciation on fixed capital in branches of material production.

NMP is based on the Marxian distinction between "productive" (i.e.,

material producing) and "nonproductive" (i.e., services) branches of

the economy. The exact definition of this distinction is not clear,

compounded by the fact that the detailed methodology of computing NMP

is not published. (U.S. CIA, 1975)

In addition, NMP excludes most personal services as well as

services provided by the government. Insofar as these factors can be

considered legitimate components of national income, their exclusion is

a defect on NMP.

Also, NMP, as calculated by the Soviets, probably includes as

final product (the sum of net outputs) goods normally considered to

be intermediate. Most probably, defense expenditures are hidden in the

inadequately defined consumption and accumulation account of Soviet

NMP. (U.S. CIA, 1975)

The Soviet output measures must be translated into a form

which is compatible with the Western concept of national income, the

gross national product (GNP). GNP is the value of final output of

goods and services, gross of depreciation deductions. The reconstruc-

tion of Soviet output statistics into a gross national product is

based on the pioneering work of Bergson (1961) and further developed

by Becker (1969; 1975; 1976). The following description is based

primarily on the more recent work of the Office of Economic Research,

Central Intelligence Agency (OER/CIA) (1975).

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The accounting system divides all economic activity into two sectors--the household sector and the public sector. The public sector includes government, the producing enterprises, and public organizations (e.g., the Communist Party, trade unions, and voluntary associations). Income and outlay accounts are constructed for each sector. Conceptually, income equals outlay in each sector. The major categories of household income are:

1. State wages and salaries.

2. Net income of households from agriculture.

3. Income of the armed forces.

4. Other money income currently earned and statistical discrepancy.

5. Imputed net rent.

6. Imputed value of owner-supplied building services.

Household outlays are classified into the following categories:

1. Retail sales of goods for consumption.

2. Consumer services.

3. Consumption-in-kind.

4. Investment.

5. Transfer outlays.

Public sector income is classified as:

1. Net income retained by organizations.

2. Charges to economic enterprises for special funds.

3. Taxes and other payments to the budget.

4. Allowances for subsidized losses, n.e.c.

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5. Depreciation.

6. Transfer receipts.

Public sector outlays consist of

1. Communal services.

2. General administrative and miscellaneous services.

3. Gross investment.

4. Research and development.

5. Outlays n.e.c. (defense, net exports, and unidentified outlays) and statistical discrepancy.

6. Transfer outlays.

GNP by end use is constructed by combining household and public sector outlays (net of transfers). The residual in GNP by end use, Outlays, n.e.c., is equal to total public sector income minus explicit public sector outlays.

GNP be sector of origin is constructed by combining household and public sector incomes (net of transfers). The residual, unidentified money income and statistical discrepancy, is derived by subtracting household incomes from household outlays.

GNP by end use and by sector of origin both involve the sum of a set of control data and a residual. In GNP by end use, the control data is total public sector incomes; in GNP by sector of origin, it is household outlays (including transfers). The accuracy of the resulting GNP estimate is thus dependent upon the accuracy of the control data and their related residual. Comparing the control data, it appears that household outlays are more accurate than public sector incomes. The largest component of household outlays is retail sles, which is

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officially reported with a high estimated degree of accuracy. The miscellaneous charges under the public sector incomes may be several billion rubles too high or too low by CIA estimates. Thus, the uncertainty in public sector incomes is probably considerably higher than the uncertainty in household outlays.

Comparing the residual data to the control data one finds that household incomes are less accurate than household outlays, and that public sector outlays are less accurate than public sector incomes. This follows from the residual calculations. Thus, GNP by end use contains the relative extremes of accuracy and inaccuracy, whereas GNP by sector of origin contains more intermediate levels of accuracy. From this it is not clear which is more accurate. However, the public sector residual is about twice as large as the household residual. Furthermore, the public sector residual may be several billion rubles too high or too low. Thus, the accuracy gap between public sector incomes and outlays is greater than that between household outlays and incomes. On balance, total incomes are more accurate than total outlays, and thus GNP by sector of origin is more accurate than GNP by end use.

GNP accounts can also be calculated at established prices or at factor costs. Established prices are "(1) prices fixed by the Soviet government, (2) officially approved market prices, or (3) costs of government services as reflected in official statistical data." (U.S. CIA, 1976, p. 2) GNP in established prices can be reported either by sector of origin or by end use.

However, the official Soviet prices do not necessarily take account of the actual resource cost involved in production. Factor cost prices are "established prices adjusted to better reflect the full resource cost of capital and labor." (U.S. CIA, 1976, p. 2) The primary adjustments consist of subtracting taxes, adding subsidies, and imputing costs of productive factors.

Soviet established prices fail to reflect resource costs in three ways. First, they exclude resource costs such as depreciation on housing and interest on capital. Thus, one must add charges on fixed and working capital and depreciation is "nonproductive" services. Second, they include turnover and other indirect taxes, state subsidies, and profits, which represent resource costs imperfectly or not at all. Thus, one must remove these charges by subtracting profits and in-direct taxes and by adding subsidies (which can be considered as negative taxes). Third, the opportunity cost of military conscripts is not accounted for. Thus, an adjustment must be made to wages (including in-kind payments) and social insurance of military personnel.

These adjustments of GNP from established prices to factor costs are calculated by sector of origin. Having estimated the factor cost adjustments for the sector of origin, one must distribute these adjustments among the end use categories. The changes in deliveries to final demand resulting from changes in value added (i.e., the factor cost adjustments by sector of origin) are determined using an interindustry matrix estimated on the basis of a Soviet input-output

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table. These changes in deliveries to final value are then distributed among the various end uses based on a percentage distribution of each producing sector's final demand among the end use sectors.

Current GNP series must be deflated to produce a constant price series in order to separate the effects of price and real output changes. Such an adjustment is usually accomplished by applying deflators to each outlay category. Unfortunately, as Becker (1976, p. 51) points out,

> ...it appears impossible to revalue the entire set of national product estimates at prices of a single year in this period. This is because of insufficient information on changes in price levels as well as the heterogeneity of the few price indexes or constant-price series available. Consequently, the deflated estimates are something of a hodgepodge from the viewpoint of statistical purism, but unavoidably so.

Soviet indices do not consistently follow the same structure and weighting schemes. Output indices generally follow a Paasche form (final year weights) and are based on year to year links. Several specific problems exist in interpreting Soviet indices. First, only a subcategory of goods is often used to produce the indices. To the extent that the selected goods are more or less subject to overall price changes, the resulting indices will be biased. This is a prime reason that outlays for several sectors (e.g., Machine Building and Metal Working) show constant or declining prices, depsite known price inflation. Second, the index forms make no allowance for quality changes in the supposedly standardized goods. A quality decrease is equivalent to an increase in the deflator. (Becker, 1976)

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As mentioned previously, no Soviet output series reflects a homogeneous collection of current or constant prices. As an example of this intermingling of prices, consider the housing sector. According to Becker (1976), the value of housing services is computed by applying a constant unit rental rate to the housing stock. Thus, the housing c ts in the current GNP series reflects a constant value estimate. Additionally, several of the generally smaller categories are not subject to deflation due to lack of an appropriate index and to their small impact on the final series.

The heterogeneous structure of Soviet indices complicates the adjustment for different base years. Since the Soviets release almost no information as to the structure and composition of their indices, it is quite possible that changing weights are a prime reason for discrepancies between different year bases.

The available Soviet indices are based on Soviet pricing policies and, hence, are compatible with the established price GNP series. The residual categories from each of the GNP series are normally deflated by an average factor based on the other GNP categories. (Becker, 1976) Commonly, the same deflator factors are used for the factor cost GNP series and for GNP series based on sector of origin. Obviously, numerous assumptions must be made since the original indices are almost all based on end use established prices.

APPENDIX E

THE SOVIET STATE BUDGET

The Soviet state budget provides a measure, albeit an ambiguous one, of the physical priorities of the annual economic plan. This section summarizes several studies on the scope and composition of this budget. Emphasis will be on the validity of the component budget numbers, especially as they pertain to alternative estimates of Soviet defense expenditures.

The Soviet state budget consolidates the budgets of all governmental levels--all-union, individual republics, and local, The budget is prepared by the Ministry of Finance and approved by the Supreme Soviet. The actual allocations are made through the Ministry of Finance and the State Bank.

According to Lee (1977), State budget expenditures are divided into five categories: Groups, Divisions, Chapters, Paragraphs, and Artic'es. The published budget consists of the five groups and associated Divisions listed in Table 18. Lee, however, contends that the actual budget probably consists of the eight Groups listed in Table 19. The budgetary substructure underlying these Groups are, as expected, obscure.

Lee (1977, p. 300) notes several basic difficulties in tracking defense related expenditures through the maze of budget categories.

TABLE 18

PUBLISHED STRUCTURE OF THE USSR STATE BUDGET

Group I: Financing the National Economy

    Divisions:

    Industry
    Agriculture
    Trade
    Transport
    Communications
    Communal economy
    (Residual)

Group II: Socio-Cultural Measures

    Divisions:

    Education
    Science
    Social Security
    Social Insurance
    Aid to Mothers
    Social Security for *Kolkhoz* members
    Physical Culture

Group III: Defense

Group IV: Administration

Group V: State Loans

(Group VI): Residual

SOURCE: Lee, William T. The Estimation of Soviet Defense Expenditures, 1955-75 - An Unconventional Approach, p. 302.

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TABLE 19

PROBABLE ACTUAL BUDGET STRUCTURE

Group Number	Divisions	Division Numerical Designators
I	(FNE) ministries and institutions	1-199
II	Sociocultural measures (SCM)	200-207
III	Ministry of Defense (MOD)	208
IV	Ministry of Internal Affairs (MVD), Committee for State Security (KGB), Courts and Procurator, ministries, institutions (State administration)	210, 211-213 214
V	Reserve funds (*sredstv*) of organs of Soviet power	216
VI	Funds transferred to lower (Republic and local) budgets	217-218
VII	Accounts with the bands	220
VIII	Various payments, other expenditures	221, 222-242

SOURCE: Lee, William T. The Estimates of Soviet Defense Expenditures, 1955-75 - An Unconventional Approach, p. 303.

> ...the industrial ministries, to which the R&D insti-
> tutions and the factories that develop and produce the
> weaponry are subordinate, may re-eive grants for in-
> vestment in fixed and working capital from Group I,
> grants to cover the cost of prototype fabrication from
> Group I, basic and applied R&D funds from the "Science"
> appropriation under Group II, and payments for some
> products from the "Defense" appropriation under Group
> III.

Thus, as noted earlier, Western analysts agree that the published "Defense" figure in Group III does not reflect total Soviet defense spending. The disagreement lies in how much of the total is actually in Group III and what the magnitude and location of the excluded expenditures are. The defense appropriations quite likely represent an operating budget, excluding such items as procurement of military equipment and research and development. While "Defense" is one of the most arcane budget category, similar problems permeate the entire document. The next section will cover the major problems with each of the Group accounts with an emphasis on how they affect the reconstruction of Soviet defense expenditures.

Budget Details

Table 20 presents the planned and actual Soviet budget expenditure figures for the period 1965 through 1976. Actual expenditures increased at an annualized rate of 7.57 percent over this period.

Financing the National Economy

Productive Soviet economic units (state industrial, construction, agricultural, trade, etc.) are theoretically self-supporting entities.

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TABLE 2.0

USSR: EXPENDITURES OF THE STATE BUDGET[a]
Billion Current Rubles

	1965 Actual	1966 Actual	1967 Actual	1968 Actual	1969 Actual	1970 Actual	1971 Actual	1972 Actual	1973 Actual	1974 Actual	1975 Actual	1976 Actual	1977 Plan
Total	101.62	105.58	115.24	128.56	138.53	154.60	164.15	173.22	183.98	197.18	214.52	226.7	238.73
Financing the national economy	44.92	45.18	52.76	58.73	62.38	74.55	80.44	84.93	91.33	99.18	110.70	118.5	123.39
Industry and construction	20.99	21.06	23.53	24.15	24.68	30.53	32.53	34.05	36.45	40.59	47.01	NA	49.1
Agriculture and procurement	6.77	6.30	6.96	7.27	10.65	12.37	12.91	13.38	15.45	17.15	19.08	NA	19.4
Trade	2.27	2.84	4.92	6.09	6.43	6.26	6.39	6.55	6.80	3.11	4.43	NA	5.3
Transportation and communications	2.83	2.61	2.62	2.65	2.99	3.11	3.11	3.49	3.59	4.14	4.96	54	9.24
Municipal economy and housing	4.23	4.53	5.05	5.25	5.89	6.44	7.08	7.33	7.42	8.18	9.80	54	36.0
Residual	7.82	7.84	9.68	11.32	11.64	15.82	18.50	20.11	21.62	25.19	26.42	80.7	83.85
Social-cultural measures	38.16	40.76	43.88	48.31	51.86	55.94	59.44	63.49	67.34	71.39	77.04	33.8	34.8
Education, Science, and Culture	17.51	18.73	20.09	21.85	23.31	24.77	26.30	27.95	29.81	31.57	32.79	11.8	12.0
Health and physical culture	6.67	7.10	7.45	8.14	8.55	9.28	9.62	10.03	10.50	10.47	11.47	35.1	37.1
Social welfare measures	13.98	14.93	15.94	18.32	20.00	21.85	23.52	25.51	27.03	28.76	32.78	17.4	17.23
Defense[c]	12.78	13.40	14.50	16.70	17.70	17.85	17.85	17.90	17.65	17.43	17.43	2.1	2.03
Administration[d]	1.28	1.41	1.51	1.53	1.72	1.66	1.78	1.80	1.86	1.34	2.0	1.3	1.30
Law service	0.10	0.10	0.20	0.20	0.20	0.10	0.10	0.08	1.1	1.1	1.3		
Budgetary expenditures residual and reserve funds of the Councils of Ministers[e]	4.38	4.73	2.79	3.00	4.67	4.50	4.54	5.02	5.51	5.73	6.24	6.7	10.93

a. Because of rounding, components may not add to the totals shown.

b. Estimated.

c. Probably excluding outlays for most of military R&D, space, internal security forces, procurement of major weapons systems, and possibly other defense related items.

d. Including financing for all local and central government agencies, such as planning and financial bodies, ministries, government departments, and the courts and judicial organs.

e. The budget plan includes Reserve funds of the Councils of Ministers. Presumably, these are normally reclassified under the functional budget categories in the actual budget; that is, the plan measure includes both the Reserve funds and the expenditures residual. The actual measure includes only the expenditures residual.

The general economic reforms of 1965 had this as a major objective.
To accomplish these reforms:

> ...(1) enterprises were given greater financial autonomy
> and decision making authority; (2) profits and the profit
> rate were made important criteria in the system of incen-
> tives; (3) a charge was imposed for the use of enterprise
> capital--formerly largely an interest-freegrant--and enter-
> prises were to finance most of their investment out of
> retained profits; (4) prices were increased so as to raise
> the profit rate and facilitate self-finance; and (5)
> enterprises were to be organized into various types of
> associations, which were expected to finance their
> activities from internal profits, a principle ultimately
> to be extended to the industrial ministries. (U.S. NFAC,
> 1977, p. 2)

Despite their theoretically self-supportint status, these pro-
ductive enterprises to continue to receive budget suppor'. This
support serves such diverse purposes as a means to increase the in-
centives to employ advanced production technology and as incentives to
produce new generation products. Table 21 lists the titles of the
articles of expenditure by which the Group I (FNE) funds are disbursed.
However, Lee (1977, p. 301) notes that "...only one distribution of
Group I expenditures by the functional articles of expenditure has been
published, at least since World War II."

During the period 1965-1975 Industry and Construction, the
largest FNE category, grew at an annualized rate of 8.4 percent.
Centralized capital investment in the industrial ministries absorbed
10-12 billion rubles in 1975. Smaller allocations were made to the
other categories, such as capital repair, working capital, and costs
of prototype production. Non-budgetary sources of financing Industry
and Construction grew from 49 percent of all-source financing in 1965

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TABLE 21

TITLES AND NUMERICAL DESIGNATORS FOR GROUP I (FNE)

Article Number	Title
24	Capital Investments in *Khozraschet*[a] Organizations and Enterprises Within the State Plan for Capital (Investment) Work
25	Capital Investments of *Khozraschet* Organizations and Enterprises Not Included in the State Plan for Capital (Investment) Work.
26	Model Designing (*Tipovoye Proyktirovaniye*) and Norm-Setting (*Normativnyye*) Work
27	Technioeconomic Substantiation and Project-Design (*Proyektnyye*) Work in Regional and City Planning (*Planirovka*)
28	Financing an Expansion in Own (*Sobstvennykh*) Working Capital Quotas (*Normativov*)
29	Appropriations to Cover Underquota Deficits in Own Working Capital
30	State Subsidies
31	Operational (*Operatsionnyye*) Expenditures
32	Other Expenditures
33	Appropriations for Forming Basic Herds of Draft and Productive Livestock
34	Bonus Markups (*Premii-nadbavki*)
35	Payments on Loans Obtained for the Development of the Housing and Communal Economy
36	Expenditures on Bonuses

TABLE 21 (continued)

Article Number	Title
42	Capital Repair
53	Covering the Planned Losses of Enterprises and Organizations on the Housing and Communal Economy

SOURCE: Lee, William T. The Estimation of Soviet Defense Expenditures, 1955-75 — An Unconventional Approach, p. 306.

[a]Organizations operating on the principle of economic accountability.

to 63 percent in 1969 before leveling off at approximately 60-64 percent in later years. (U.S. NFAC, 1977, pp. 7-8) The reduction was in accord with the 1965 price reforms objective of encouraging enterprise self-financing.

.Despite the greater emphasis on the use of enterprise funds, budget expenditures on agriculture grew at an annualized rate of 10.4 percent between 1965-1975. This increase reflects the increased priority given to increasing agricultural production by the Brezhnev regime. The largest portion of budget expenditures is allocated to capital investment, with lesser amounts going for such activities as land improvements, expansion of livestock herds, and land reclamation.

The sharp drop in trade expenditures since 1973 possibly resulted from a redefinition of the trade category. Significant end uses include "...working capital, investment, 'the carrying out of foreign trade operations for exports and imports of goods,' and subsidies." (U.S. FAC, 1977, p. 10)

The vast majority of budget funds for Transportation and Communications supports the transportation sector. The lower growth rate in this expenditure category (5.6 percent) reflects the greater reliance on non-budgetary sources of financing.

The Municipal Economy and Housing sector budget outlays cover activities such as city services; road maintenance; investment and repair of apartment complexes, warehouses and supply organizations; and housing repair. These expenditures have increased by 7.3 percent in the 1965-1975 period.

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The total of the above six major Divisions under FNE does not equal the published total for Finacing the National Economy. The residual has grown dramatically in the 1965-1975 period (12.8 percent annualized rate) and is thought to include:

1. Additions to state material reserves (of both civilian and military-related goods).

2. Special accounts for price regulation (to cover enterprise losses due to unforeseen price changes).

3. Any economic sectors, ministries, and agencies not included in the announced allocations under FNE (for example, Inturist). In addition, any budget subsidies on agricultural products that were not treated as subsidies to the food processing industry would probably be included in this residual. (U.S. NFAC, 1977, p. 11)

Temporal changes in the percentages of total financing of FNE Divisions provided by the budget are shown in Table 22. The relative reduction in government financing is in accord with the objectives of the 1965 price reforms.

The decrease in budgetary support for FNE enterprises complicates any attempt to reconstruct national output by end use. Table 23 presents an attempt by the Central Intelligence Agency to provide such a reconstruction. The primary source of the Agency data was a breakdown provided by V. A. Yevdokimov, chief editor of Finansy SSSR, the monthly journal of the Ministry of Finance.

TABLE 22

USSR: PLANNED EXPENDITURES FOR FINANCING
THE NATIONAL ECONOMY (ALL-SOURCE FINANCING)

	PERCENT				
	1965	1970	1975	1976	1977
Total	100	100	100	100	100
From the Budget	56	49	49	50	49
From Other Sources	44	51	51	50	51
Industry and Construction					
From the Budget	51	37	38	40	38
From Other Sources	49	63	62	60	62
Agriculture and Procurement					
From the Budget	56	49	47	49	47
From Other Sources	44	51	53	51	53
Trade					
From the Budget	69	82	NA	NA	62
From Other Sources	31	18	NA	NA	38
Transportation and Communications					
From the Budget	35	23	24	25	26
From Other Sources	65	77	76	75	74
Municipal Economy and Housing					
From the Budget	88	NA	NA	83	NA
From Other Sources	12	NA	NA	17	NA
Residual					
From the Budget	78	NA	NA	NA	NA
From Other Sources	22	NA	NA	NA	NA

SOURCE: National Foreign Assessment Center. The Soviet State
Budget Since 1965, ER77-10529, p. 7.

TABLE 23

USSR: FINANCING OF THE NATIONAL ECONOMY BY END USE

	Billion Current Rubles					
	1970	1971	1972	1973	1974	1975
Total	75	80	85	91	100	111
Investment	25-27	28-30	29-31	33-34	34-36	37-39
Working Capital	3-4	2-3	3-4	3-4	3-4	3-4
Capital Repair	2-3	3-4	3-4	3-4	4-5	4-5
Subsidies	17-18	18-19	19-20	20-21	21-22	22-23
Operational Outlays	4-5	7-8	8-9	8-9	9-10	11-12
Other Expenditures	18-24	16-22	17-23	19-24	23-29	28-34
Midpoint of "other expenditures"	21	19	20	22	26	31
	Percent					
Midpoint of "other expenditures" as a share of FNE	28	24	24	24	26	28

SOURCE: National Foreign Assessment Center. The Soviet State Budget Since 1965, ER77-10529, p. 12.

Socio-Cultural Measures

Socio-cultural measures is the only other Group in the Soviet state budget for which expenditures by Divisions are published. Table 24 lists the numbers and titles of the articles of expenditures for this Group (II). Lee notes that the Soviets periodically (approximately every five years) publish the distribution of Group II funds by articles of expenditures, except for the "Science" appropriation. The Group II articles, it should be noted, differ basically from those of Group I. According to Lee (1977, p. 301), "The former are functional programmatic articles, while the latter simply are various inputs." As a result, end product identification is not possible using the Group II articles.

Budget expenditures for Socio-cultural measures have increased at an annualized rate of 7.0 percent in the period 1965-1976. During this same period, however, its share of the total budget declined from 38 percent to 36 percent. The CIA attributes this decline to such factors as "...(a) the demands of the national economy as well as military programs, (b) the greater role of nonbudgetary resources in financing SCM, and (c) the slower relative growth of SCM outlays." State budget financing of SCM activities declined as a percentage of all-source financing from 84 percent in 1965 to 79 percent in 1976. (U.S. NFAC, 1977, p. 13)

As in the United States, the growth in the socio-cultural portion of the state budget is due primarily to increases in the social insurance and social security programs. Specific examples of these increases include:

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TABLE 24

TITLES AND NUMERICAL DESIGNATORS FOR GROUP II (SCM)

Article Number	Title
1	Wages
2	Social Insurance
3	Office and Organizational (Econ-mic) Expenses
4	Travel Expenses
5	Educational Expenses, Expenses of Students Engaged in Production, Scientific Research Work, and Acquisition of Books for Libraries
8	Stipends
9	Expenditures on Food
10	Purchases of Medical Supplies
12	Purchases of Equipment and Supplies (Inventory)
13	Extra-capital investment (Not Included in the State Plan for Capital Investment), Excluding Items Purchased Under Article 12
14	Acquisition of Clothing ("Soft Inventory")
15	Capital Investment in Facilities
16	Capital Repair of Buildings and Facilities
18	Other Expenditures

SOURCES: Lee, Witliam T. The Estimation of Soviet Defense Expenditures, 1955-1975 — An Unconventional Approach, p. 306.

1. Rising pension and welfare grants, which are tied to
    workers' earnings. About 46 million[1] people, or
    almost 18 percent of the population are receiving
    pensions in 1977 — compared with 26 million pensioners,
    or 11 percent of the population in 1965.

2. Wider coverage of existing benefits such as the exten-
    sion of pension privileges to collective farm workers
    in 1965. The state budget provided almost 2.4 billion
    rubles to this pension fund in 1975, underwriting about
    two-thirds of the program's cost, with collective
    farmers receiving pensions in 1976 — 4 million more
    than in 1966, the first full year of the farmers'
    pension program.

3. The introduction of new programs, such as the 1974
    announced program of ch-ldren's allowances to low-
    income families. The cost of this program may be
    about 1.8 billion rubles. (U.S. NFAC, 1977, p. 14)

Science expenditures have a particular significance in all
budgetary methods for estimating Soviet defense expenditures. Currently,
the most authoritative position (recently adopted by the CIA in their
direct costing approach and previously advocated by Lee in his uncon-
ventional approach) relies on a statement by the Soviet economist,
Trapezhnikov, that only about 25 percent of reported "Science" expendi-
tures are devoted to military research, development, test, and evalua-
tion (RDT&E). Table 25 presents a comparison between total reported
science expenditures and the budgeted "Science" category.

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[1]The average monthly wage for all workers rose from 96.5 rubles
in 1965 to 151.4 rubles in 1976. Also, the minimum pension for indus-
trial workers was raised in 1971 from 30 rubles to 45 rubles per month.
(U.S. NFAC, 1977, p. 14)

TABLE 25

USSR: EXPENDITURES FOR SCIENCE
(Billion Current Rubles)

	1965	1966	1967	1968	1969	1970	1971	1972	1973	1974	1975	1976
Total reported science expenditures	6.90	7.50	8.20	9.00	10.00	11.70	13.00	14.40	15.70	16.45	17.40	17.7
Science budget category	4.27	4.61	5.05	5.52	5.88	6.54	7.02	7.30	7.64	3.04	8.03	NA
Other budget categories and nonbudget financing	2.63	2.89	3.15	3.48	4.12	5.16	5.98	7.10	8.06	8.41	9.37	NA
Budgetary allocation for science as a share of total reported science expenditures (percent)	62	61	62	61	59	56	54	51	49	49	46	NA

SOURCE: National Foreign Assessment Center. The Soviet State Budget Since 1965, ER77-10529, p. 15.

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Even fewer expenditure details are available on the remaining
state budget Groups than given for the two Groups just discussed. Thus,
remaining Groups will receive rather brief coverage. Speculation con-
cerning the role of the "Defense" Group and the budget residual in
financing Soviet defense expenditures is included in the last section
of this chapter.

Defense

Analysts are in agreement that the single line entry for defense
in the Soviet state budget does not include the same categories of
expenditures as in the U.S. defense budget. In a forthcoming article
in Soviet Studies, "A Note on the Meaning of the Soviet Defense Budget,"
CIA analysts Robert Leggett and Sheldon Rabin support the position that
"...the announced defense budget is largely a current expenditures
budget of the Soviet military establishment. As such, it would probably
include pay and allowances of military personnel, wages of civilian
MOD employees, current repair of facilities, pensions, food and non-
food quartermasters supplies, utilities, and the like." (U.S. NFAC,
1977, p. 16) This definition appears to leave out construction expendi-
tures, the only major difference between the CIA's and Lee's (1977)
analyses on the composition of the published "Defense" budget. Both
analyses agree that operating expenditures have increased during the
1970s, contrary to the decline in the published budget. The joint
reason given for this discrepancy is the political manipulation of the
announced expenditures on defense. The magnitude of such manipulations

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can only be approximated using either the CIA's direct costing approach or Lee's adjustment factor. Lee (1977) estimates operating expenditures during the 1970s as 148 percent of personal expenditures (a relationship which held during the period 1968-1970).

Administration

The published "Administration" line "covers the cost of government operations--wages, social security contributions, office expenses, and other administrative costs--for the judicial system, central and local legislative bodies and ministries (including, possibly, the central office costs of the MOD), the planning and financial apparatus, and embassies and consulates abroad." (U.S. NFAC, 1977, p. 17) The low figure (2.1 billion rubles in 1976) given for "Administration" has lead to the conclusion that "official Soviet statistics grossly understate both the cost of government administration and the level of employment in the 'apparat'." (U.S. NFAC, 1977, p. 17)

Loan Service

Loan services cover the principal and interest payments on the public debt. In 1957 the Soviet government announced a twenty year moratorium or repayments on subscription bonds. Redemption of the outstanding 25.8 billion rubles in subscription loans was resumed in late 1974. Initial repayment rates averaged 1-1.5 bi-lion rubles in the 1970s. Final repayment is scheduled for 1990.

Reserve Fund for the Council of Ministers

The Soviet budget plan includes an allowance for a reserve funds of the union and republican Council of Ministers. The amount of the reserves can be approximated by the difference between the planned and the actual total budget "Residuals". During the period 1965-1976 this has averaged 2.3 billion rubles per year. Uses of these funds may include:

(1) Emergency and disaster relief. From time to time the government publicizes outlays from the reserve funds, such as the financing of disaster relief in flood stricken republics. The amounts involved, however, probably comprise a very small portion of the total reserve funds expended in any given year.

(2) Expenses occasioned by unforeseen developments in the international arena. All-union reserve funds were possibly used in 1968 to help finance the resupply of the Arab armies after the 1967 Six-Day War as well as the August invasion of Czechoslovakia. Those outlays would explain in part why reserve fund rose from 1.25 billion rubles in 1967 to a re 6.17 billion rubles in 1968.

(3) Supplemental financing for the national economy, social-cultural measures, and other measures not envisioned at the beginning of the year. (U.S. NFAC, 1977, p. 18)

The Budgetary Expenditures Residual

The total budget residual is calculated by subtracting the totals for the primary categories from the overall budget. Possible activities funded through the residual include the Committee for State Security (KGB) and other internal security activities and foreign aid.

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APPENDIX F

FINANCIAL ASPECTS OF THE SOVIET ECONOMY

This chapter summarizes the financial aspects of the Soviet economy, emphasizing the Soviet financial system, price system, and tax system. Comparisons between certain aspects of the Soviet economy will also be made with that of the United States.

Two main features distinguish the Soviet economy from that of the United States: 1) state ownership of the means of production, and 2) planner sovereignty. Each will be discussed separately.

State Ownership

In the Unites States, productive enterprises are owned by private individuals, and the profits derived from these enterprises belong to the owners.

In contrast, there are three kinds of ownership in the Soviet Uion. State ownership is ownership by the government. Cooperative ownership is ownership by a cooperative association in which the members of the cooperative organization are either its workers or its customers. Private ownership is ownership by individuals. (Bergson, 1964)

The great majority of productive enterprises are state owned. The state owns all industry, as well as a network of state farms (*soukhozy*). These state forms are run on the same basis as industrial

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enterprises (as factories in the field). Wages are paid at an hourly or piece rate. The major form of cooperative organization is the collective farms (*kolkhozy*). The income of the collective farmers are determined by the income of the collective farm. (In addition, many collective farmers receive income from the sales proceeds from their private plots.) In recent years, the collective farmers have also received a guaranteed minimum income from the state at state farm wage rates. (Bornstein, 1974) The network of cooperative stores in villages is actually state-operated. (Garvy, 1974) Many collective farmers and some urban workers own private farm plots, the output of which may be sold in the collective farm markets. (All land is actually owned by the government.) (Berson, 1964) In addition, there is an insignificant number of private farmers, artisans, doctors, etc., engaged in productive activity.

Planner Sovereignty

In a market economy, such as that of the United States, decisions regarding production and distribution are made by firms operating in the marketplace. Striving to maximize profits, these firms compete for the patronage of consumers. It is in each firm's best interest to produce those goods that consumers want in quantities and at prices determined by the forces of supply and demand. This state of affairs, in which the desires of consumers determine the output of productive enterprises, is called consumer sovereignty.

In the Soviet Union, decisions regarding the kinds and sources of inputs used, output produced, and destination of outputs are

specified by the government for each enterprise or group of enterprises. Resources are allocated according to the various central plans. This state of affairs, in which the dictates of planners determine the output of productive enterprises, is called planner sovereignty.

The Soviet Financial System

Although resources are transferred by directives from state planners, money serves as the medium of exchange for these resources.

The central plan is a physical plan. Quantities are usually expressed in physical rather than in monetary terms. The role of money is limited to two main functions.

First, as a unit of account, money serves the planners as a common denominator for aggregating physically dissimilar quantities. By attaching a monetary value to physical quantities, the planners can compare and evaluate different possible input or output combinations.

Second, as a medium of exchange, money is used to facilitate and complete transactions. At least in theory, resources can be transferred without a reciprocal transfer of money. In actual practice, however, exchange proves more convenient than unilateral transfer. (Garvey, 1974)

In market economies, such as that of the United States, there are money markets that provide capital and credit. Monetary flows are determined by the interaction of the commodity and the money markets.

In a command economy, such as that of the Soviet Union, there are no money markets. Monetary flows are determined in the financial plan. This plan is designed solely to implement the physical plan.

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Monetary flows are planned as counterparts to physical flows at the planned prices. (Garvey, 1974)

There are two kinds of money in the Soviet Union--currency and bank deposits. Currency serves as money for households. Wages are paid and goods are purchased in currency. Bank deposits serve as money for enterprises. Payments between enterprises are made by deposit transfers. The bank credits the account of the buyer and debits the account of the seller. (Garvey, 1974) The two kinds of money are not interchangeable. Deposits are converted to currency almost exclusively through payroll withdrawals. Savings account withdrawals are also made in currency. This currency is converted back into deposits when individuals make retail purchases or service expenditures, pay income taxes, or add to their savings accounts. State owned and cooperative retail stores and service establishments are required to deposit all currency receipts in excess of a stipulated amount of petty cash on a daily basis. Efforts are made to prevent households from hoarding currency. (Garvey, 1974)

The separation of monies leads to an almost complete separation of markets for consumer and producer goods. Each form of money has a limited command over resources. Individuals can use currency to acquire only consumer goods and certain restricted kinds of property, to make deposits into their savings accounts, and to purchase government bonds. Small service establishments, artisans, and independent farmers can also acquire producer goods, but such purchases are insignificant. Bank deposits of enterprises may be transferred only if the purchase is allowed by the plan. (Furthermore, any purchase

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stipulated in the plan not only is permitted, but receives any necessary credit for financing almost automatically. Thus enterprises gain no advantage by accumulating excess liquidity.) The separation of monies and the restrictions on the use of each money, limit the concept of a total money supply (a concept not used in formulating Soviet policy). (Garvey, 1974)

There are three kinds of transactions: 1) transactions with the population, 2) transactions between state enterprises, and 3) transactions with or within the stage budget. (Garvey, 1974)

Wages and other incomes are paid mostly in currency. A small amount of these payments is paid directly into savings accounts. Collective farmers receive most of their farm-earned income as well as all of the proceeds from the sale of output from their private plots in case (the remainder of income from the farm being in kind). All purchases of consumer goods and services are made in currency.

Payments between enterprises not exceeding 100 rubles may be made in currency. State owned enterprises must use deposits for larger transactions. Collective farms must use deposits for all transactions with the state budget, with all state owned enterprises, and with the credit system.[1] State agricultural procurement agencies largely use currency to purchase output from collective firms. Claims arising among state owned enterprises are nonnegotiable and nonassugnable. They may be settled through deposit transfers or through mutual

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[1] All collective farm accounts related to capital formation must also be kept in deposits in Gosbank (the state bank). However, collective farms may also keep funds in currency and in savings accounts. (Garvey, 1974)

offsetting of claims, a slow and complex process. (Garvey, 1974)
These payments are automatically linked to the movement of goods between enterprises.

Transfers of funds to, within, and from the state budget are made by means of deposit transfers.

As previously mentioned, the Soviet monetary policy does not seek to manipulate the total quantity of money. Instead, monetary policy seeks to complement the physical plan.

The total quantity of currenty in circulation is carefully controlled. Planners seek to balance the incomes paid to workers with the volume and prices of consumer goods available. Gosbank is careful to insure that currency is issued to enterprises and that payments of governmental units and wages conform with the cash plan.

The cash plan is part of the financial plan, which also includes the state budget and the credit plan. The state budget determines the sources and volume of revenues, establishes the volume and end use of expenditures, and attempts (successfully) to balance revenues and expenditures. The credit plan regulates short term and long term credit policies by the banks that seek to finance planned inventories and investments. Thus, Soviet monetary policy, which differs from that in capitalist countries, is accompanied by fiscal policy as well as price setting policy in the overall financial plan. Thus, it complements the physical plan. (Shaffer, 1969)

Banking

There are three banks in the Soviet Union: Gosbank, the Investment Bank (*Stroibank*, also called the Construction Bank), and

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the Foreign Trade Bank (*Vneshtorgbank*). Almost all banking functions

are performed by Gosbank. The transactions of the other two banks is

limited to those functions not assigned to Gosbank. (Gregory and

Stuart, 1974)

Gosbank is the Soviet Union's monopoly bank. A monopoly bank

combines the functions of central and commerial banking; however,

since some central bank functions are unnecessary in a planned economy,

they are, therefore, omitted. Like a central bank, and like any

"monobank", Gosbank is the bank of issue: it regulates banknote

circulation. It also manages gold reserves. However, since there

are no financial markets and since credit is directly controlled by

the monobank, there is no need for functions such as the control of

reserves of independent commercial banks (which do not exist in the

Soviet Union), open market operations, discounting, etc. These func-

tions are performed by central banks in market economies like the

United States, but they are not performed by monobanks such as Gosbank.

(Gregory and Stuart, 1974, Oxenfeldt and Holubnychy, 1965)

Gosbank holds all deposit accounts. Its deposits include the

current accounts of the government at all levels, state owned enter-

prises, collective farms, and any other enterprises that operate on the

basis of *Khozraschet*,[2] and other organizations such as trade unions and

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[2]The Russian word is used because there is no exact English
translation. Roughly translated, *khozraschet* means economic accounting
or cost accounting. *Khozraschet* enterprises are those enterprises that
have the r own working capital and prepare their own balance sheet and
income statement--i.e., those that have financial autonomy.

the Party. Such organizations have no access to credit. Finally, since 1963 Gosbank's deposits have included all savings accounts (both of individuals and of cooperative organizations, including collective farms). (Garvey, 1974; Shaffer, 1969)

In 1963, the savings bank system was incorporated as a department of Gosbank. This department has two functions: it holds savings accounts at a 3 percent annual rate of interest on deposits, and it sells government bonds (which earn a similar interest rate). The volume of these accounts is small, because less than 2 percent of consumer net income each year is deposited in savings accounts. (Garvey, 1974)

Aggregate balances held in Gosbank are small, relative to cash balances held by business and government (federal, state, and local) in the United States. In addition to its deposits, Gosbank receives budgetary grants and the bulk of any budget surplus. It also retains a portion of its own profits. (Nove, 1977)

Gosbank is the settlements and clearing center of the country, the sole source of short-term credit, and the fiscal agent of the government. All accounts, both current and savings, are on deposit in Gosbank. All currency is issued by Gosbank. All non-currency transactions are made on the books of Gosbank. Thus, Gosbank is the settlements and clearing center of the country. (Garvey, 1974)

Gosbank is the depository of the state budget. It keeps the accounts of the national government as well as those of all subordinate governmental units. It collects taxes and any other payments due the treasury by debiting the depositor's account (automatically in most

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cases). It even extends any credit necessary to meet such payments.

Gosbank also disburses revenue to pay for government activities.

Finally, it issues and redeems public loans. Thus, Gosbank is the

fiscal agent of the government. (Garvey, 1974)

Through its first two functions Gosbank plays a major role in

planning. It is involved in the creation, enactment, and evaluation

of the physical plan. Its primary duty is to support the enactment of

the plan once it has been approved.[3] Gosbank attempts to prevent un-

planned spending (purchases in quantities or at prices in excess of

those allowed in the plan). Not only does it deny credit beyond that

stipulated in the financial plan (which follows the physical plan),

but it also prevents transactions that violate the rules (the plan that

is enacted into law). On the other hand, Gosbank will usually auto-

matically grant any credit needed to make planned expenditures. How-

ever, if an enterprise does not disburse its planned expenditures in

their full amounts, there is little or nothing that Gosbank can do.

(Garvey, 1974; Nove, 1977)

Gosbank aids in the evaluation of the plan by monitoring the

plan's enactment. Because all transfers of goods require corresponding

financial payments, and because all financial transactions between

state owned enterprises are made by transfers of deposits on the books

of Gosbank, all transfers of goods are, therefore, recorded in Gosbank

accounts. Gosbank is able to audit the flow of goods (production and

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[3]In fact, in Gosbank's lending operations, meeting the
borrower's financial obligations to the bank is subordinated to the
borrower's execution of the plan. (Garvey, 1974)

all but the final distribution to consumers) in the economy. Not only can Gosbank tell whether the plan is followed, but it can also determine whether the plan itself functions smoothly. Problems such as bottlenecks and disequilibrium in the planned real flows can be spotted.[4] When Gosbank finds problems, it does not change its financial policy (of implementing the plan) in an attempt to correct for the physical plan's deficiencies. It merely alerts the planning authorities, who may then attempt to amend the physical plan if they deem such action proper. Gosbank monitors and implements, but does not correct the existing plan. (Oxenfeldt and Holubnychy, 1965)

Since Gosbank cannot affect real flows once the plan has been accepted, it participates in the creation of the physical plan. In this way the information revealed to Gosbank as it monitors the plan may be used to improve the plan. Naturally, Gosbank also helps to prepare the financial plan. (Garvey, 1974)

The Investment Bank finances fixed capital investment in two ways: it disburses state budget grants, and it provides long-term credit to state enterprises and collective farms.[5] Long-term credit provided by the Investment Bank constitutes most of the total long-term credit of enterprises. However, long-term credit constitutes less than 10 percent of the total credit. (Garvey, 1974) Furthermore, only a small (but increasing) fraction of investment is financed from long-term

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[4]Gosbank is the main if not the only source of such information.

[5]See the previous discussion of long-term credit extension by Gosbank.

credit, whereas budget grants remain a major source of investment funds. Because long-term credit is relatively insignificant, the Investment Bank is essentially an administrative organization.

The Foreign Trade Bank manages foreign exchange reserves. It handles international payments and receipts, and it provides credit for foreign trade. Like the Investment Bank, the Foreign Trade Bank is essentially an administrative organization. (Gregory and Stuart, 1974; Nove, 1969)

Money and Banking, and Gosbank in particular, play a key role in all stages of planning. Economic planning in the Soviet Union relies heavily on the control of monitary flows.

Financing Enterprise Operations

Enterprises finance their day-to-day productive operations from two sources: their own working capital and short-term credit. Loans from Gosbank are available to finance all production costs. Gosbank credits provide between 40 and 50 percent of planned total working capital, the percentage varying by type of working capital. The dividing line between borrowed and owned working capital is not really significant. All capital of state enterprises is owned by the government. The enterprises merely serve as custodians for the state's capital. In the past, if an enterprise needed working capital it not only could receive more short-term credit, but it could also be granted more working capital (either through budget grants or administrative transfers from other enterprises). However, enterprises no longer receive working capital grants. Additional working capital may be

gained only through bank credit. The reason planners make enterprises rely heavily on bank credit to meet their working capital needs is to enable Gosbank to exert tighter control over enterprises. (Bornstein, 1974)

Enterprises need short-term credit to help pay expenses when they are incurred faster than payments are received. This gap can arise either when inputs are delivered ahead of schedule or when output is used to expand inventories. Enterprises borrow to cover the gap between expenditures and receipts. Unless planners change the balance between enterprise funds and bank credit in total working capital, changes in the volume of credit correspond to changes in volume of inventories. Short-term loans are secured almost entirely by the physical assets of and payments due to the borrowing enterprise. These loans must be repaid out of enterprise profits. (Nove, 1977)

All short-term credit to enterprises is officially extended by Gosbank, but in practice there are exceptions. Enterprises may not extend credit, and they receive pressure to pay on time. However, payments are sometimes delayed. These delays are equivalent to the extension of involuntary credit by the supplier. Advance payments by state procurement agencies to collective farms also constitute credit extension. Almost no credit is available to private enterprise. Short-term credit to consumers is provided by stores, but not by Gosbank. (Garvey, 1974) Aside from these three exceptions (delayed payments, advance payments, and consumer loans), Gosbank provides all short-term credit. Gosbank's extension of credit is determined

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according to the physical plan. Since Gosbank has no reserve requirements and cannot lose funds to any other bank, there is no limit to the amount of credit the Gosbank can extend other than the financial plan. (Garvey, 1974)

Interest rates on short-term credit are fixed by the planners. They vary according to the type of borrower and the purpose of the load. All interest rates on short-term credit are low. No interest is payable until the credit is repaid. Industrial enterprises pay 2.2 percent annual interest. State farms pay 3 percent (5 percent if repayment is overdue). Collective farms pay 1 percent (3 percent if repayment is overdue). Trading organizations pay 2 percent (4 percent if repayment is overdue) annual interest on short-term capital. (Nove, 1977)

The annual interest rates on short-term credit are much lower than the charge on fixed and working capital. This charge is approximately 6 percent annually, with modest differences according to industry. Thus, it is cheaper for enterprises to borrow rather than use their own resources. (Nove, 1977)

Financing Investment

Total investments[6] in the Soviet Union consist of state

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[6]
Investment as a Percentage of GNP
U.S. average for 1962-1977... 17.5
Soviet Union for 1970........ 31.2

Sources: U.S. from a W. R. Grace and Co. advertisement in the Los Angeles Times, July 26, 1979, Part III, p. 19.
Soviet figure from U.S. Central Intelligence Agency (1975, p. 1).

investments, collective farm investments, and individual and coopera-
tive housing investments. State investments consist of centralized
(centrally planned) and decentralized investments. Gross investment
includes capital repairs and replacements through depreciation. Net
investment excludes depreciation. Soviet enterprises have a deprecia-
tion fund that is used partially to finance recorded investments and
partially to finance capital repairs which are not included in the
investment figures.[7] Thus the Soviet figure for total investments is
greater than net investments but less than gross investments. (Nove,
1969)

Most investment in the Soviet Union is centrally planned.
Furthermore, decentralized investment is subject to restrictions set
by the central planners. It is important to distinguish between
centrally planned and centrally funded investment. The central invest-
ment plan includes investment financed by enterprises and bank credit
as well as by grants from the state budget. All centrally funded
investment is centrally planned, but not *vice versa*. Thus decentralized
funding does not necessarily ent il decentralized decision making.
(Nove, 1969)

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[7]Depreciation charges are included in the cost of Soviet
enterprise. Depreciation costs tend to be understated in the Soviet
Union because the service life of fixed assets tends to be over-
estimated, and depreciation charges are calculated on the basis of
original cost without upward adjustment for the effects of inflation
on replacement cost. Furthermore, original costs of some fixed assets
are understated because subsidies for certain construction work are
not included in costs, and no depreciation is charged on agricultural
capital. Finally, costs of obsolescence are not taken into account.
(Bergson, 1961)

State budget grants are the major source of funds for centralized (centrally planned) investment. Since most centralized investment (i.e., most investment) is financed by the budget, an enterprise's liquidity position does not affect its investment plan. The retained profits and the depreciation function of enterprises provide a sizeable and increasing portion of centralized investment. Long-term credit provided by the Investment Bank plays a small, but growing, role in financing centralized investment. There is a trend toward substituting repayable loans for nonreturnable grants. Enterprises are permitted to retain a greater share of profits as well as depreciation reserves. Thus, the tendency is to shift away from centralized funding toward decentralized funding with respect to centralized investments. However, there is no movement to reduce centralized investments in favor of decentralized investments. (Garvey, 1974; Nove, 1977)

Decentralized investments are financed from enterprise resources (retained profits and depreciation fund) and from long-term credit from the Investment Bank. It is not financed from state budget grants. Decentralized investment constitutes only about 13 percent of state investment. (Nove, 1969)

Collective farm investments are financed from the capital fund of each collective farm and from long-term credit from the Investment Bank. The amount of credit extended for capital investment in agriculture is quite deficient relative to needs. (Garvey, 1974; Nove, 1969)

Private and cooperative housing is financed through private and cooperative savings accounts and through long-term loans from Gosbank. The role of savings in total investment (not just housing) is insignificant. The annual interest rate on long-term credit is 0.5 percent.[8]

The Soviet Price System

In a competitive market, prices are determined by supply and demand. If supply exceeds demand, firms lower their prices and reduce output. Alternatively, if demand exceeds supply, firms raise their prices and increase output. The market always moves automatically toward equilibrium in which supply and demand are equal.

Marginal cost is the cost of the last unit of output produced (i.e., the cost on the margin). Marginal revenue is the price of the last unit of output sold. If marginal cost exceeds marginal revenue, a firm is producing and selling some goods at a loss. The firm will then reduce output, which will reduce supply and raise the equilibrium price (which is equal to marginal revenue). If marginal revenue exceeds marginal cost, a firm can increase its sales and profits by increasing output. The increase in supply will lower the equilibrium price. Marginal revenue will decrease, but total revenue and profits

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[8]This rate of interest applies to centralized investment. Nove (1969:1977) reports a 0.5 percent interest rate for centralized investment in both 1967 and 1972. He further reports a 2 percent rate for decentralized investment in 1967, and rates as low as 1.75 percent for collective farms under a decision made in 1957.

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to the firm will increase. Thus, a profit maximizing firm will set
marginal cost equal to marginal revenue.

The marginal price of an input (such as labor or capital) is
the price of the last unit hired. Marginal product is the increment
to total output due to an increment of some input. If the marginal
price of any input exceeds its marginal product, the firm is paying
that input more than it is producing, on the margin. As a result, the
firm will employ less of that input. If the marginal product of any
input exceeds its marginal price, then, on the margin, the firm is
paying that input less than it is producing. The firm is making a
profit by employing the input, and it will try to increase profits by
hiring more of the input. The increased demand for the input will
raise its equilibrium price. Thus, a profit maximizing firm will pay
each input according to its marginal product.

Market prices are scarcity prices--they reflect the scarcity
of a good's supply relative to demand. A good in great supply but
in even greater demand is scarce. A good in meager supply that no
one wants is abundant. Because market prices are scarcity prices, they
reflect the full resource cost of a commodity. And, because market
prices reflect resource costs, they guide firms in employing resources
as efficiently as possible.[9] For this reason, market prices (as well
as scarcity prices are formed in a market) are also called efficiency
prices.

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[9]Resources are employed efficiently if the output of no good
can be increased without decreasing the output of some other good. It
can be demonstrated that perfectly competitive markets are efficient.

Despite the theoretical possibility of operating a command economy without money, the Soviet Union finds it convenient to use money. Since the Soviet economy is a money economy, all goods have money prices. These prices perform three main functions: 1) planning, 2) resource allocation, and 3) income determination.

Money serves as a unit of account. Planners need a common denominator in which to express input and output targets. Money prices are such a denominator. Management performance is evaluated partially according to profits, which are affected by prices. Control by the ruble would be impossible without prices. Thus, prices play a key role in the formulation and enforcement of the plan; they also aid in controlling and evaluating management performance. (Bornstein, 1974)

For planning purposes it is advantageous to have stable prices. The vast and complex set of calculations involved with planning becomes even more complex if prices change during the periods covered by the calculations.

Resource Allocation

Prices guide planners in devising means to further government economic policies. Central planners use prices to construct macro-economic balances, to substitute more abundant for scarcer materials, and to assess the benefits of various alternative projects.

However, the usefulness of prices in guiding planned allocation of resources is limited. Because prices are set administratively, they rarely reflect resource costs accurately. Thus, they do not guide the planners to an efficient use of resources. However, resources are

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allocated nonetheless. These proxy prices are thus an inefficient but workable substitute for scarcity prices. (Gregory and Stuart, 1974)

Another problem is that planners sometime ignore the price signlas that are received. As shall be shown later in the discussion of the turnover tax, planners do not expand or contract supply in response to demand.

Prices also guide enterprise decisions at the microeconomic level. Managers use relative prices to make choices of inputs and outputs not specified by planners. However, there is a paradox here. Before prices are set, enterprises have an incentive to use more expensive inputs to increase their costs of production. The planners use enterprise cost estimates to partially determine prices, seeking to offset production costs. Prices will be set artificially high to cover the inflated costs. However, once prices are set, enterprises try to use cheaper inputs. Both practices are designed to increase profits. (Nove, 1977)

For purposes of allocation, it is advantageous to have prices vary to reflect changes in the scarcity of supply relative to demand. This condition will lead to an efficient allocation of resources. However, as mentioned earlier, stable prices are advantageous for planning. Price goals for planning and for resource allocation inherently conflict, and the respective objectives must somehow be balanced.

Income Determination

Wages, prices, direct taxes on personal income, and transfer payments are all used in conjunction with each other to determine the

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state's income policy. (Bornstein, 1974) This policy accomplishes three major objectives.

First, planners strive to equate total after tax, disposable money income with the aggregate value of consumer goods available at the official prices. The cost of producing these consumer goods is equal to the income derived from their production. Income is also derived from investment (the production of capital goods) and from the provision of government services. Thus, total pre-tax money income available to purchase consumer goods exceeds the production costs of these goods. The government reduces disposable income by taxing income. Retail prices are set higher than production and distribution costs, with the markup consisting of enterprise profits and indirect taxes (mainly turnover taxes and payments from profits). In this way, an aggregate balance of supply and demand for consumer goods is achieved. (Nove, 1977)

Second, planners try to equate the supply and demand for each good. This is accomplished by setting the price of each good low enough to clear the market without creating a shortage of the good. (Bornstein, 1974)

Third, planners try to make the distribution of real income more equitable than the distribution of money income. Unequal monetary compensation is used as an incentive for production. Three methods are used to make the distribution of real income more equitable. First, progressive income taxes and transfer payments to the poor reduce the advantage of a higher income. Second, prices for mass

consumption goods are set low relative to the prices of luxury goods. Thus, an increase in disposable income will yield a smaller increase in consumption. Finally, many services such as health and education are considered to be public goods. They are financed from the state budget so that a low income will not lead to reduced consumption of these services. Because of these three ways, the distribution of real income is more equitable than the distribution of money income. (Bornstein, 1974)

Soviet Price Theory

There are three principal schools of thought among Soviet economists--the Marxian school, the mathematical school, and the market school.

The Marxian School

The Marxian school maintains that prices of goods should conform to the value of the goods. In Marxian value theory, the value of a good is equal to the amount of past and present "socially necessary" labor embodied in the good.[10] The value of past labor and the depreciation of plant and equipment that is used up in production are called constant capital, denoted by c. The value of current paid labor is called variable capital and is denoted by v. The value of current unpaid labor is called surplus value or product and is denoted by m

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[10]Socially necessary labor is labor at average skill, with average effort, and under average conditions (with "average" as yet undefined).

(*mehrwert*). The value (*stoimost'*) of a good is equal to the sum (Gregory and Stuart, 1974)

$$value = c + v + m.$$

Members of the Marxian school disagree on how surplus value should be calculated. One group advocated basing m on average cost (*sebestoimost'*, which is usually taken as $c + v$). Another group holds that labor cost should be used. A third group favors using capital, and a fourth group proposed using a combination of labor cost and capital. (Bornstein, 1974) In the 1966-67 price reform, the state decided to calculate m and set profit rates on the basis of capital.

The Mathematical School

The members of the mathematical school criticize the more traditional Marxian school because prices under the latter system do not reflect resource costs and relative scarcity. According to the mathematical school, state planners should set output goals. These goals may be maximized in a linear programming model with the factors of production (land and capital as well as labor) as constraints. A cost minimization combination of inputs would thus be found to achieve the output plan. Factor prices may be computed as the change in the value of the output function due to a change in each factor (i.e., shadow prices). These prices would be scarcity prices, and would produce an efficient solution of the plan. Unfortunately, the means of gathering and processing the vast amount of data required by this approach are not yet available. (Bornstein, 1974)

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The Market School

The market shcool also advocated scarcity prices. However, its members propose that prices be determined by the forces of supply and demand in the market rather than be administrative direction. State enterprises would then compete for supplies and for sales. Since the state would own the enterprises and any profits, enterpise profits would not be exploitive.[11] This approach is known as market socialism. (Gregory and Stuart, 1974)

Soviet Price Policy

Prices are supposed to equal the average cost of production for each industry plus a profit markup. Capital charges, interest, and rent are not included in costs. However, they are subtracted from profits, and the net profit figure is the one that counts in judging and rewarding management performance. (Nove, 1969)

In practice, while some enterprises make large profits, other enterprises must sell at a loss. There are three main reasons why prices sometimes fail to cover cost.

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[11]According to Marx, all value derives solely from labor, either directly (through present labor) or indirectly (through past labor embodied in plant and equipment). Surplus value is direct labor for which the laborer is not paid. Profit is taken to be surplus value. When a capitalist makes a profit, he is receiving labor for which he does not fully pay. He exploits the laborer, who in turn is alienated. However, if the profit belongs to the state instead of to a capitalist, the laborer is not alienated. This is so because the workers own and are the state. The worker is not exploited, for in giving a portion of his labor to the state, he is giving it to himself. One could then say that the laborer exploits himself.

First, planners may deliberately set prices below costs for certain goods. This may be done to encourage consumption of the good or to make the good affordable to more people. Sometimes when this is done, planners expect the loss to the enterprise to be offset by profits on the sales of other products. However, these profits are not always sufficient to cover the loss. If an enterprise must operate at a net loss, the deficit is subsidized by the state budget. (Bornstein, 1974)

Second, costs may change after prices are set. If costs increase, the firm's profit margin may be eroded, or even become losses.

Third, because prices are based on average cost, firms with higher than average costs face reduced profits and even losses. There is some support in the Soviet Union for a move toward (but not to) marginal cost pricing. Under the various proposals, prices would be based on the cost of production of enterprises with the worst conditions but with average efficiency. This scheme would allow most enterprises to cover their costs of operation. It would also encourage efficiency, since the least efficient firms could still suffer a loss. So far the government has not adopted such a policy.[12] (Bornstein, 1974)

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[12]Such a policy still would not be true marginal cost pricing. The proposals base prices on the marginal cost for the entire industry, or within a region. Enterprises with lower costs would sell at a price above their marginal cost. The use of average cost is still established doctrine. Apparently this is so because Marx dealt with average costs. However, it has been shown that at Marx's level of abstraction, marginal and average costs would be equal. This would account for Marx's neglect of marginal costs and might clear the way for some move toward, if not to, marginal cost pricing. (Nove, 1977)

However, even if all these difficulties could be solved, the fundamental approach is still deficient. Because cost-plus prices are not scarcity prices, any such prices will lead to an inefficient allocation of resources. For prices to serve as accurate indicators to management and planners, they must reflect relative scarcity. They must make it more profitable to produce and more costly to use or waste items that are scarce relative to supply and demand. Any cost-plus prices are inaccurate indicators. At best they can lead to only a rough approximation of an efficient allocation of resources. (Nove, 1977)

Labor

Wages are determined by the state. However, labor is not forced, and workers are fairly mobile. If the state sets wages too low, it will not attract the desired labor supply. There is a *de facto* labor market in which the state must respond to the forces of supply and demand. (Nove, 1969) It therefore follows that wages conform at least roughtly to the marginal product of labor.

Capital

The Soviet government has reluctantly recognized that capital constributes to output. Philosophically, since the supply of capital is limited, the users of capital should pay a price for its use. Along with the 1966-67 price reform, the government made four important managerial reforms.

First, managerial success is now measured by profitability as well as total output. Second, enterprises are encouraged to economize on capital. Enterprises must pay the state an approximate annual charge of 6 percent on the value of fixed (original cost less depreciation) and working capital. New investment is to be financed more by bank credit and less by state budget grants. As mentioned previously, profits are set on the basis of capital. Third, enterprises now retain a larger share of profits. Fourth, enterprise managers have additional authority to adjust the use of labor of different skill (and wage rates) to produce output at reduced costs. (Bornstein, 1974)

The greater emphasis on profit maximization, and especially the acceptance of an explicit capital charge, indicate that capital will be more properly valued in Soviet prices. Since the charges for capital do not bear the intended relationship to the opportunity cost of the use of capital, capital charges do not (yet) conform to the marginal product of capital.

Land

Academic and government recognition of the value of land is growing in the Soviet Union. There is some explicit rent. (Bornstein, 1974) There is also an attempt to collect an implicit rent. Where prices are differentiated by zone, enterprises in higher cost zones receive a higher price. Instead of allowing every enterprise to receive higher prices and charging low cost enterprises higher rent (better endowed and situated land should command a higher rent),

enterprises with lower costs receive a lower price. The effect on an enterprise's profit is the same whether it receives a high price and pays rent or receives a low price and pays no rent. In theory, the difference in prices between good land and bad land is equal to "rent in disguise". (Nove, 1969) However, the zonal price system is imperfect. Furthermore, the explicit rent is arbitrary. Therefore, rent does not reflect the opportunity cost of using land, i.e., rent does not accurately conform to the marginal product of land.

Since 1965, the majority of prices in the Soviet Union have been set by the State Price Committee. In addition to directly setting prices, the State Price Committee establishes principles for setting all prices. It also supervises the enforcement of prices once they are established. (Bornstein, 1974)

Price committees in the rebpulics set most of the remaining prices. Enterprises may set only those prices not determined by these committees. Such prices normally apply only to new products and special (higher quality) orders. However, in addition to setting these few prices, enterprises can affect the prices set for them. Planners estimate costs on the basis of past experience and on the basis of enterprise estimates. The price is then set equal to estimated cost plus planned profit. Thus, through their initial cost estimates, enterprises can negotiate a higher price.

Price revision is a massive and complex task. As a result, prices are revised infrequently. Prices of products that undergo no technological change do not change between major price revisions. When

a produce changes, or when a new product is introduced, the price may

change, but only in accord with the regulations. The new price will be

based on the old price plus the cost of in-roducing new technology.[13]

Industrial Wholesale Prices

Industrial wholesale prices cover prices of producer goods, in-

cluding raw materials, semifabricates, and machinery as well as manu-

factured consumer goods. They exclude prices of agricultural products

obtained by the state procurement agencies from collective farms, but

they include prices set by procurement agencies that sell agricultural

products to state enterprises for processing. They also exclude foreign

trade prices, but they include the prices of foreign trade organizations

that buy from and sell to Soviet enterprises. (Bornstein, 1974) There

are two industrial wholesale prices, the enterprise wholesale price, and

the industry wholesale price.

Enterprise Wholesale Prices

The enterprise wholesale price is the price at which a producing

enterprise sells its output to other producing enterprises and to

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[13]The Soviet price system tends to discourage the adoption of technological improvements. Both producing enterprises and their customers must bear a cost of implementation, while older methods could still be used to produce at a lower cost and sell at a lower price in the short-run. In the long-run, new technology could lower costs and prices. The problem is to set prices for improved goods enough above those of old goods to make it profitable for enterprises to innovate, but not so much above the old prices that customers will prefer to buy to old goods and the old prices. The Soviets attempt to deal with this problem by setting a price schedule with a high initial price, followed by a periodic reduction of prices. The success of this method has been limited. (Bornstein, 1976)

distributing enterprises. Sometimes, due to large disparities in natural conditions, producers of the same product in different areas receive different prices. These varying prices are called accounting prices. The wholesaler pays each producing enterprise a different accounting price depending on what price zone the enterprise is in. The wholesaler then charges a uniform industry wholesale price. (Bornstein, 1974)

Industry Wholesale Prices

The industry wholesale price is the price charged to buyers outside the given industry. It consists of the enterprise wholesale price plus any transportation costs, the wholesaler's markup, and the turnover tax. The turnover tax makes it possible to alter enterprise wholesale prices without making equivalent changes in industry wholesale prices and retail prices, and *vice versa*. An increase or decrease in enterprise wholesale prices can be offset by a decrease or increase in turnover taxes. Likewise, retail prices, and therefore industry wholesale prices, may be changed by decreasing or increasing turnover taxes. Normal pricing policy determines the desired retail price and enterprise wholesale price, and then establishes the turnover tax as the difference between the two prices (excluding transportation costs and distributor markup). (Bornstein, 1974)

Agricultural Procurement Prices

The price charges by agricultural procurement agencies consists of the agricultural procurement price plus the procurement agency

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markup, any transportation costs paid by the procurement agency, and the turnover tax (or subsidy). The agricultural procurement price is the price at which the state or collective farm sells to the procurement agency. (Bergson, 1961)

The Soviet Union is divided into agricultural zones of differing costs. Agricultural procurement prices are differentiated by zone to accommodate the cost differences. However, this price zoning system is inadequate. Between zones, price variations are less severe than cost variations. Within zones, costs can vary greatly while prices vary less or not at all. (Bornstein, 1974)

A certain procurement price is paid for agricultural goods up to the quota established in the delivery plan. A 50 percent bonus is paid for over-quota grain delivered. Because of this bonus, average prices, both for farms and for the agricultural industry as a whole, tend to rise and fall as output increases and decreases. This paradoxical price behavior is the opposite of price behavior in a market economy, where prices tend to change inversely with supply. (Gregory and Stuart, 1974)

Both state and collective farms pay roughly equal costs and receive roughly equal prices. This situation did not hold in the past, and although it holds imperfectly now, the trend is toward equalization of costs and prices for similarly situated farms. In the past costs and prices for collective farms were higher than for state farms. Collective farms used to pay retail prices for some goods for which state farms paid wholesale prices. Now collective farms also pay wholesale prices. The conversion of many state farms to (greater) self-financing

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has been made possible by allowing the converted farms to receive the same prices as do the collective farms. (Bornstein, 1974)

Retail Prices

There are two kinds of retail prices in the Soviet Union, state retail prices, and collective farm market prices.

State Retail Prices. The state retail price is the price charged by state retail stores, consumer cooperative stores (which are state-operated), and state and cooperative service establishments. (Bornstein, 1974) State retail prices are set to clear the market. The aggregate level of retail prices is set to absorb the money income of the populace (after direct taxes on income), and the retail price of each good is set to equate planned supply with expected demand.

The objective of equating supply and demand is, however, balanced with three other objectives--stable prices, a more equitable distribution of real income, and various social objectives. As examples of the third objective, the price of vodka is set high to discourage consumption, while the prices of children's clothing are set low to encourage consumption. (Nove, 1977)

Collective Farm Market Prices. The agricultural output of private farmers, of the private plots of collective farmers and urban workers, and collective farm output beyond state purchases is sold in what are called collective farm markets. Prices in collective farm markets are determined by supply and demand in the individual market. They vary from market to market, and from day to day in the same market.

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Collective farm market sales comprise less than 3 percent of total agricultural sales. However, total sales include many food goods which are not sold in the other markets. Counting only those goods sold in the other markets, collective farm market sales were 8 percent of total sales in 1971. In some cities, collective farm markets account for 20 to 40 percent of total sales of major food products. (Bornstein, 1974) For certain goods, market sales comprise a very large share of total sales nationwide. For example, in 1970, 67 percent of potato sales, 54 percent of egg sales, and 35 percent of meat sales were made in the collective farm markets. (Gregory and Stuart, 1974)

Demand is the markets depends upon how much purchasing power remains after direct taxes on income. State retail stores compete with the collective farm markets for consumer demand. Supply in the market depends on the amount of output left to collective farms after their sales to state procurement agencies and the output of private plots. These collective farm market prices fluctuate sharply, inversely to the size of the harvest. Market prices exceed state retail prices by large but varying amounts due to both below equilibrium prices in state stores and better quality in the markets. (Bornstein, 1974)

Foreign Trade Prices

Much of Soviet foreign trade is conducted with the member countries of the Council for Mutual Economic Assistance (CMEA or Comecon). CMEA consists mainly of the Soviet Union and the socialist countries of Eastern Europe. Prices for trade between CMEA countries are set by mutual agreement between the planning authorities of all CMEA

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countries. (Trade between any two countries is conducted at prices set by all member countries, for all member countries.) CMEA prices are not directly affected by changes in world market prices, however, CMEA prices are sometimes set on the basis of past world prices. (Brougher, 1976)

The main objective of Soviet foreign trade is to import goods that are deemed necessary for socialist economic development. Soviet import policy is to import only these goods. The foreign trade corporations of the Soviet government have a monopoly: all foreign trade is conducted through them. The Soviet government sets import quotas for foreign trade. Tariffs are not needed or used to discourage unwanted imports. For this reason, previously protective tariff rates were sharply reduced in 1961. Tariff rates are now quite low and are not a major source of revenue. (For this reason, they are not included in the discussion of the Soviet tax system.) The Soviet Union uses tariffs only to encourage other nations to grant the Soviets most-favored-nation status. If other nations lower tariffs on Soviet goods, the Soviets reciprocate by reducing tariff schedules to those nations. (Smith, 1973)

Soviet foreign trade corporations generally purchase imports at prevailing world market prices and sell them to Soviet purchasers at whatever price is set by the planners. (Nove, 1977)

Soviet export policy is to export whatever goods are necessary to pay for the needed imports. The foreign trade corporations try to be as profitable as possible while obtaining the foreign currency needed to purchase imports. Prices on export goods are always set to be low

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enough to gain business, but not any lower than necessary. These prices are sometimes far below world market prices; sometimes they are far below costs. Thus, the Soviets occasionally engage in what we call dumping, in practice, if not by intent.[14] (Flegon, 1965)

Domestic prices of manufactured goods in the Soviet Union tend to be set below world market prices, although some internal wholesale prices are above world prices. Foreign trade corporations pay Soviet suppliers the official domestic price. (Nove, 1977; Ericson, 1976)

The Soviet Tax System

Since World War II the Soviet Union has both planned and had a budget surplus. The Soviet government derives revenues from the social sector (economic organizations and enterprises) and from the private sector (individuals). Social sector revenues constitute over 90 percent of total revenues, and are derived entirely from indirect (commodity) taxes. (U.S. CIA, 1977) Indirect taxes are those taxes included in the retail prices of consumer goods. Direct (income) taxes include all deductions from individual income before expenditures. (Turgeon, 1969) Private sector revenues consist mainly of direct taxes (the remainder being non-tax items rather than indirect taxes).[15]

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[14]Dumping is selling at a price below fair market value (or below cost). It is done normally to injure foreign competition. The Soviets do not seek to reduce the sales of foreign businesses. They seek to obtain adequate sales for their purposes.

[15]Other sources of revenue from the private sector include state loans, local taxes, and lotteries. Before 1958, state loans were compulsory. In 1958 compulsory bond purchases were abolished, and repayment of these loans was suspended. (Nove, 1969; 1977) In 1973 the

Indirect Taxes

The state budget received total revenues of 232.2 billion rubles in 1976. Of this total, 91 percent came from the social sector as indirect taxes. (U.S. CIA, 1977)

Turnover Tax. The turnover tax is a sales tax included in the price of a commodity. It equals the retail price minus the enterprise wholesale price (production costs plus profit), transportation costs and handling markups. It is levied in three different eays.

First, it may be levied at a fixed rate, like an excise duty. Second, it may be levied by acquiring farm output at a low price and selling it at a higher price. When agricultural products are required to be sold at a procurement price that is barely above or even below costs, the farm effectively pays a tax in kind.[16] (Nove, 1969)

Third, and most common, it may be levied as a "tax by difference". The retail price is set to equate supply and demand. The enterprise wholesale price is set equal to average costs plus a small percentage profit margin. Transportation costs and handling margins are likewise set. The turnover tax is determined to be the difference between the retail price and the production and distribution costs and profits. (Nove, 1969)

Soviets commenced redemption of 25.8 billion rubles in outstanding loans. Repayments are to be made periodically until this public debt is retired in 1990. Taken together, these various sources provide less than 1 percent of total budget revenues. (U.S. CIA, 1977)

[16]There have been cases in which transportation costs alone exceeded the compulsory delivery prices. (Nove, 1969)

Often the turnover tax may contain elements of more than one
or even all three methods. For example, in 1948 a ton of rye was pur-
chased from the collective farms for, at most, 8 rubles,[17] which was
about the same price paid in 1928. Because costs had risen greatly
since 1928, the rye was then sold to the state millers at 338 rubles
for the ton. The turnover tax levied on rye accounted for the bulk of
the difference between 8 and 338 rubles. The tax fell on both the
collective farm peasants and on the urban consumers in uncertain pro-
portions. (Nove, 1977)

A turnover tax is collected on a wide range of consumer goods.
It is also charged oil, gas, and electricity, supposedly to balance
these prices with that of coal and to each other. Farm output sold in
the free market or used for stockpiling or for export is exempt, as are
almost all producer goods (including military hardware items). (Nove,
1969; U.S. CIA, 1977) For some goods used both by producers and by
consumers, state enterprises may be partially or completely exempt
from the turnover tax that is otherwise included in the industry whole-
sale price. Thus, there may be two industry wholesale prices charged,
depending upon the use for which the specific consignment under con-
sideration is destined. The amount of the turnover tax varies with
each item, but the general level of the tax is quite high. Unfor-
tunately, with few exceptions, the actual rates are not published. The

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[17]On January 1, 1961 the Soviet Union revalued the ruble in the
ratio of ten to one: ten old rubles equal one new ruble. All figures
used in this study are in new rubles.

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METHODOLOGIES FOR ESTIMATING AND COMPARING SOVIET DEFENSE EXPEN--ETC(U)

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rates are kept secret, presumably so that Soviet consumers will not know how much tax they pay. (Nove, 1969)

The actual method of collecting the turnover tax varies. Sometimes it is paid by the wholesaler or by the procurement agency. More often it is paid by the producing enterprise. Thus, the tax is paid before the taxed goods are sold to the final customers. It is still paid even if no one eventually buys the goods. (Nove, 1977)

Three objections are raised to the turnover tax. First, the turnover tax imposes a barrier that prevents producing enterprises from responding to retail price signals. A rise in retail prices will normally raise turnover taxes and industry wholesale prices, but will leave enterprise wholesale prices unchanged. Enterprises receive no signal to expand or contract supply in response to demand. (Of course, their response would be severely limited by the plan even if they did receive retail price signals.) The state receives such information according to the response of the turnover tax, but it usually does not change output accordingly. (Nove, 1969)

Second, since the turnover tax is levied mainly on consumer goods, the money-measured (i.e., established price) share of consumer goods relative to producer goods in the national economy is inflated. This distortion can be reduced in the national income reporting by omitting the tax and subsidies from the prices of goods, i.e., calculations should be made at factor cost.

Third, because the turnover tax is levied mainly on consumer goods, an unfair tax burden is placed on consumers who pay higher

retail prices than on producing enterprises that pay no turnover tax. This criticism is not really valid since retail prices normally determine the turnover tax and are not determined by it. The state cannot simply cut the turnover tax to loer prices, although it can lower retail prices to cut the turnover tax. Retail prices are determined by the relationship between personal disposable incomes and the goods and services planners make available for consumption. Charging turnover tax on producer goods would lower the turnover tax on consumer goods, but it would raise the production costs of consumer goods. Input costs would include turnover tax. The cost structure would be altered, but retail prices would remain the same (Nove, 1969)

There are also three claimed advantages to the turnover tax. First, the turnover tax allows the government to equate disposable income with the aggregate value of consumer goods and to equate supply and demand for individual products. Income taxes could reduce disposable income to the aggregate value of consumer goods, but they could not prevent large disparities between supply and demand for individual products. (Oxenfeldt and Holubnychy, 1965)

Second, is it asserted that the turnover tax, like any other indirect tax, is easier to administer and collect than a direct tax "in a populous, semiliterate agricultural country." (Gregory and Stuart, 1974, p. 146)

Third, indirect commodity taxes, such as the turnover tax, supposedly have less of a disincentive effect on workers than direct income taxes. Under direct taxation, the taxpayer's liability is

plain. As previously mentioned, consumers are unaware of the amount of turnover tax in each retail price. This claimed advantage assumes that the worker/consumer pays more attention to his money than to this real wages. Considerable doubt exists as to whether this money illusion does in fact exist.

The turnover tax is a major source of revenue for the Soviet government. The 1977 plan includes 73.3 billion rubles in expected turnover tax receipts--31 percent of total expected budget revenues. However, turnover tax receipts have not grown as fast as total budget revenues. Thus, the turnover tax's share of total revenue has declined from 38 percent in 1965 to 30 percent in 1976. (U.S. CIA, 1977) Furthermore, retail prices did not rise as a result of increased procurement prices for agricultural raw materials and higher wholesale prices on many other items. Turnover taxes absorbed the increases.

Some organizations pay turnover taxes and also receive a subsidy. It is not known whether turnover tax receipts from agriculture exceed subsidies paid to agriculture. (Nove, 1969)

Payments from Profits

In the Soviet Union an enterprise's profits are owned by the government, which may redistribute them. Until 1965 payments from profits consisted entirely of deductions from profits. (In fact, the entire category was called deductions from profits.) Deductions from profits were equal to the total profits of state enterprises less the amount they were permitted to retail for specified purposes. (Nove, 1977) Payments from profits do not include: 1) capital charges,

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2) fixed payments, 3) the so-called "free remainder" of profits, and
4) deductions from profits and other payments. The purpose of the
capital charge is to encourage efficient use of capital. Fixed pay-
ments are equivalent to a rent, for they are paid by enterprises for
favorable natural, transportation, and other conditions. The free
remainder of profits is the amount left after paying the first two
charges plus interest on repayment of bank loans and after payments in-
to the various enterprise funds. (Nove, 1969; 1977)

Due to increased profit margins under the 1967 price reform,
payments from profits contributed a larger share of total budget
revenue than prior to the reform. The share of budget revenue from
profit payments rose from 30.2 percent in 1965 to 36.7 percent of
total revenues in 1968. However, rising costs have since curtailed
the growth rate of profits and payments. (U.S. CIA, 1977) Moreover,
to increase enterprise self-financing, payments from profits as a per-
centage of total enterprise profits have declined from 69 percent in
1965 to 57 percent in 1976, thereby further reducing the share of
total budget revenue paid from profits. However, these payments are
not net payments, for enterprises may simultaneously receive subsidies
and pay out part of their profits. (Nove, 1969) Reductions in pay-
ments from profits are accompanied by reductions in subsidies. These
reductions may at least partially offset each other. Thus, payments
from profits are a major source of budget revenues, and are expected to
contribute 33 percent of total revenues (78.4 billion rubles) in the
1977 plan. (U.S. CIA, 1977)

Income Tax on Organizations

Collective farms and nonstate economic organizations such as consumer cooperatives pay taxes on net income. (Before 1965 collective farms were taxed on gross income.) (Nove, 1969) The income tax rates for collective farms depend on net income levels. The tax rate for consumer cooperatives is normally 35 percent of net income. The rate for other organizations is 25 percent. Numerous organization such as "economic enterprises of the Party and *Komsomol* organizations" are exempt from paying the income tax. (U.S. CIA, 1977, pp. 21-22) The income tax on organizations is relatively insignificant, providing less than 1 percent of total budget revenues.

Social Insurance Payments

Social insurance payments are paid by state enterprises as a cost of production. Such payments are calculated as a fixed percentage of the wage bill. This percentage ranges from 4.4 percentage in agriculture to 9 percent in the coal industry. Aviation and defense industries pay 7.3 percent. (U.S. CIA, 1977) Although social insurance payments provide about 5 percent of total budget revenues, they are not sufficient to cover the outlays of the Social Insurance Budget (which is administered by the trade unions and received general budget funds). (U.S. CIA, 1977)

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Residual

There is a residual of other social sector revenues. Unfortunately, the residual is composed of numerous unidentified revenue sources. No single revenue or group of revenues can explain the residual in any given year. Since the revenues come from the social sector, they must all stem from the gap between costs of production and retail prices.[18] (Nove, 1969) The residual is a major source of budget revenue, providing about 24 percent of total revenues in 1976, up from 17 percent in 1965. (U.S. CIA, 1977)

Direct Taxes

Annual revenues from the private sector, as a percentage of total budget revenues, grew from 8.2 percent in 1965 to 9 percent in 1976. More than 90 percent of private sector revenues come from direct taxes on the population. (U.S. CIA, 1977)

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[18]There is some speculation that the residual covers some form of deficit budget financing. Since the composition of the residual is unknown, it may be improper to include the entire residual under either tax or non-tax revenues.

Personal Income Taxes

Personal income taxes account for about 95 percent of direct tax revenues. Income taxes as a percentage of total money income declined from 14 percent in 1955, to 6.6 percent in 1960, and to 6.4 percent in 1965. (Bronson and Severin, 1969) However, despite repeated promises and an attempt to abolish the personal income tax (started in 1960 and aborted in 1962), the income tax has not been abolished. (Bronson and Severin, 1969).

The income tax is levied on all personal incomes other than those of collective farm peasants. The tax rate depends on the source of income, the level of income, and family size. The tax is paid at a progressive rate, ranging from 1 to 13 percent of personal income derived from employment by state enterprises and organizations (i.e., the bulk of incomes). (Nove, 1969) Wages below 70 rubles per month are tax exempt (as of 1977). (U.S. CIA, 1977) The top rate is charged on income in excess of 100 rubles per month. The top rate for writers' and artists' income is also 13 percent, although the progression differs from that of state employees. (Nove, 1977) However, royalties from foreign publication and income from private activities are taxed on a much higher scale. Minima, progressions, and maxima are all signicantly higher than for state employees' incomes. For example, an annual income of 1200 rubles is taxed at 221.40 rubles per year for private income but only 70 rubles per year for income from state sources. Private income above 7000 rubles annually is subject to a marginal tax rate of 81 percent (all figures as of 1968). (Nove, 1977) Thus,

while taxes on private earned income are quite high, most income
(which is state earned) is not heavily taxed.

Agricultural Tax

As an attempt to reduce the relative profitability of the pri-
vate sector, an agricultural tax is levied progressively on income from
farming on private plots. Collective farm peasants pay agricultural
tax on their private plots, but they pay no tax on their incomes from
the collective farms. (Nove, 1969) Since 1953, the agricultural tax
has been proportional to the area cultivated, with a higher rate for
irrigated land and a lower rate for less fertile land. Livestock
(other than working stock) at or below the norm for each republic is
not taxed. The tax liability is 50 percent greater for those collective
farm members who do not devote the prescribed number of days to working
for the collective farm. (Nove, 1969; 1977)

Bachelor and Small Family Tax

The bachelor and small family tax is paid by men of ages 20 to
50 years and married women from 20 to 45 years old. All persons with
children and unmarried women are exempt from this tax. Also exempted
are persons with low incomes, military personnel, full time students,
and a few other categories. The maximum tax rate is 6 percent of in-
come. The various rules concerning this tax have changed frequently
since its introduction in 1941. (Nove, 1969)

Republican Budget Revenue

The revenues and outlays of the republican local governments are included in the state budget. The portion of this state budget not administered directly by the all-union authorities has varied greatly over the years. In 1953, under the highly centralized government of Stalin, less than 21 percent of the state budget passed through the separate republican budgets (including local budgets). In 1958 the figure was over 50 percent. (Nove, 1969) In 1965 the figure rose to 58 percent, but in 1966 it dropped to 51 percent. Since 1966, republican budgets have comprised between 48 and 49 percent of the state budget. (U.S. CIA, 1977) However, the portion of the state budget under republican control is even smaller, for funds pass through the republican budgets that must be administered according to central direction. Thus, republican budgetary autonomy is rather limited.

Even so, the republics and local soviets do retain stated portions of various revenues raised in their territories, the proportions varying by source of revenue and by republic. Republics keep most payments from profits of enterprises under republic jurisdiction, all of the income tax on collective farms, all forestry fee revenues (included in the social sector residual), slightly more than 50 percent of personal income taxes, all of the agricultural tax, all of the bahcelor and small family tax, as well as all local taxes and fees and 50 percent of state lottery proceeds. In addition, each republic retains a portion of the turnover tax revenues collected within its territory. The proportion for each republic is established annually by the Union

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government according to its estimate of the republic's needs. Some

republics retain less than 50 percent, while others retain 100 percent.

(Nove, 1969)

Some republics or areas that are being developed actually

receive more from the central budget than they pay into it. These

practices amount to a transfer of capital from some republics to others.

It has been charged that capital investments in less developed areas

are not recovered as quickly as investments in the areas from which the

capital is taken, and that "as a result such capital transfers create

losses for both their republic [the Ukraine] and the USSR as a whole."

(Oxenfeldt and Holubnychy, 1965, p. 127)

The Burden of Soviet Taxes

The total tax burden has been defined by Nove (1977, p. 230)

as "the total difference between cost of production and final sale

prices of all goods and services, plus direct taxes less subsidies."[19]

This definition suffers from three principle defects.

First, the burden under this definition includes producer goods

production and investment undertaken by enterprises which are not owned

by the state. The collective farms in particular make profits that

should not be included in a proper definition of the tax burden.

Second, this definition of the burden includes funds retained

by state owned enterprises. These funds never reach the state budget.

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[19]This is the same definition used by Holzman (1962).

Investment is financed out of the markup on the price of consumer goods. Whether an enterprise retains profits to pay for investment or transfers profits to the state budget and pays for the investment with budgetary grants, investment is included in this definition of the tax burden. (Nove, 1977)

Third, the profits of enterprises, which are included under this definition of the tax burden, are overstated due to Soviet accounting practices. Soviet enterprises explicitly recognize the following as costs: payments for wages, raw materials, and intermediate products; depreciation; and short-term interest. Costs of capital, rent, costs of depletion, and returns for entrepreneurial ability are not included in the cost accounts. (Holtzman, 1962) Insofar as these costs are paid at all (the Soviets once hoped to do without land rent and capital charges), they are paid out of enterprise profits. The tax burden so defined is further overstated because it includes enterprise profits gross of these costs.

Under this definition, the Soviet tax burden is not comparable to the tax burden along in capitalist countries, but to the tax burden (total government spending)p plus profits of firms. In capitalist countries, where firms are owned by individuals and groups of individuals, the distinction between government and firms is clear. In the Soviet Union, enterprises are owned by (i.e., are part of) the state,[20]

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[20]This raises the question of whether payments from profits are a tax that burdens capital formation or a dividend that rewards the supplier of capital.

and accounting practices only partially separate enterprise budgets from the state budget. The distinction between government and firms is blurred in the Soviet Union. It is difficult or impossible to divide total government operations into government operations proper and enterprise operations. The definition of the total tax burden provided earlier is not proper from the standpoint of accounting purity, but at least it is calculable.

Direct Taxes

There is one task to which direct taxes are far better suited than are indirect taxes. This task is the enactment of class policy. Direct taxes are far better for discriminating against some groups and favoring others.

Specificially, indirect taxes vary according to the object of income, i.e., expenditure categories. Soviet direct taxes vary according to family size, the amount of income, and its source. By placing a higher tax on incomes earned in the private economy, the state can affect the choice of occupation.

Indirect Taxes

In the earlier discussion of the turnover tax, three advantages were listed. The second and third advantages (administrative facility and disincentive minimization) are shared with all indirect taxes. The first advantage (equating supply and demand for each individual good) applies only to the turnover tax.

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The turnover tax has another advantage over payments from profits. Because it is not affected by changes in enterprise costs (profits change, not the turnover tax), it is better able to provide a large and constant flow of revenue to the state. (Holtzman, 1962)

On the other hand, different firms have different needs that must be met by internal funds. Unless a separate tax rate were charged for every firm (an awesome task), the turnover tax could not accomodate these differences. The profits tax (payments from profits) can and does accomodate these differences.

The question remains as to whether indirect taxes fall on consumers or on enterprises. Payments from profits seem to bear most on the enterprises. However, the turnover tax bears both on the enterprise (by reducing its selling price in relation to its costs) and on the consumer (by being included in the retail prices of goods and services). The extent to which it bears on each is uncertain.

Holzman (1962, p. 66) discussed the incentive effects of taxes on the labor-leisure choice:

> Taxes also affect the work-leisure ratio, since
> they are levied on the type of income derived from
> work rather than on income from leisure. The
> direction of their influence in this area, however,
> is not always easy to determine, since taxes on work
> income produce two opposing effects. The income
> effect, which is related to the average rate of taxa-
> tion, causes a person to work harder to recover the
> income taken away by taxes. The substitution effect,
> which is related to the marginal rate of taxation,
> lessens the incentive to work, because the tax
> reduces the reward for effort (i.e., it reduces the
> cost of additional leisure).

According to Holzman, the net result of the income and substitution

effects cannot be determined because we do not know the shape of the

supply curve of labor in the Soviet Union.[21] However, in addition to

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[21]Actually, the net effect due to taxes can be known without
knowing the shape of the labor supply curve: it is definitely negative.
That is, an increase in taxes unambiguously reduces incentives and
effort. Alternatively, a decrease in net real factor returns always
reduces factor supply. This point will be demonstrated for the case of
labor.

For an individual laborer, the income effect is positive. An
increase in his taxes increases his effort unless there is an offsetting
substitution effect. His substitution effect is negative. An increase
in his taxes tends to decrease his effort. The net effect may be
positive or negative.

The effort response to taxes for the labor market as a whole is
simply the sum of the individual responses. These individual responses
may be all negative, all positive, or some negative and some positive.
The market response will be negative, positive, or roughly neutral,
correspondingly.

However, the government disposes of the taxes it collects, ei-
ther by buying productive services, including labor services, or by
making transfer payments. The market income effect is due to the
reduction in total income caused by taxes. Government outlays increase
total income, causing an income effect opposite in direction to the in-
come effect caused by taxes. Borrowing aside, outlays equal taxes.
The market income effects caused by taxes and outlays should be equal
in magnitude. They should cancel each other completely. Taxes de-
crease income, and outlays increase income, each with uncertain effects.
However, total income of the population is unchanged. There can be no
net market income effect when both taxes and outlays are considered.

Two qualifications should be made. First, there is the possi-
bility that taxes could fall only on those individuals for whom the in-
come effect dominated while outlays could go to individuals with smaller
income effect responses. In this event, taxes would increase the effort
of those taxed, and this income effect would not be canceled by the in-
come effect caused by the outlays. Anyone who proposes that the govern-
ment can, or should try to determine the effort response to taxes for
each individual (i.e., find each individual's labor-supply curve) and
tax only those individuals for whom the income effect dominates, or
anyone who contends that such a policy is already followed by random
chance instead of conscious design, is indeed an optimist.

Second, it was mentioned that government outlays may be factor
purchases or transfer payments. The former will also induce a market
substitution effect. The latter will not. The substitution effect due
to government spending runs counter to that caused by taxes. If all
taxes are spent and there are no transfers, the substitution effects
might cancel. Whether they do depends on whether there are any

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employment by the state, by a cooperative organization, or through leisure activities, there is also the possibility of self-employment as an alternative option (at least for some people, mainly in the rural areas). The availability of self-employment and leisure pursuits as alternatives to state or cooperative employment makes it more likely that taxes will discourage work for the state. Therefore, it can be concluded that the labor supply curve in the Soviet Union has a positive slope.[22]

So far, it has been shown that taxes in the Soviet Union probably tend to reduce the incentive to work, and thus to reduce the supply of labor. However, two aspects of the Soviet tax system tend to mitigate this disincentive effect.

First, since indirect taxes are much more heavily relied on than direct taxes, workers/consumers do not know their tax rates and are less affected by them. To the extent that workers/consumers are fooled by this money illusion, the heavy Soviet reliance on indirect taxes will minimize labor disincentives.

Second, to the extent that the Soviet tax system is regressive, disincentives are reduced. Progressive taxes tend to reduce work incentives. Regressive taxes tend to increase work incentives, or to

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transfers and on whether government productivity, then the net effect on output caused by equal taxes and spending will be negative. The net effect on factor supply will be neutral, but that supply will be used less efficiently.

[22]A positively sloped labor supply curve is one for which an increase in net real wages (possibly caused by a decrease in taxes) increased the supply of labor.

educe tham less severely than do progressive taxes.[23]

Holzman tentatively concludes that the turnover tax is either proportional or mildly regressive. He also finds that the income tax is mildly progressive, and that the tax structure as a whole is roughly proportional. (Holzman, 1962) Thus the disincentive effect on labor of the Soviet tax system may not be as severe as that of the U.S. tax system.

Summary

In this appendix the financial aspects of the Soviet planned economy have been examined. In such an economy, resources are allocated administratively. Administrative allocation of resources does not inherently require money or exchange. However, purely administrative allocation of resources is beyond the ability of man to use or, at least, to use well. Therefore, the Soviet Union uses money. Money is exchanged for goods at given prices. Resources for the government are not commandeered. They are paid for using money that is obtained through taxes.

The Soviet Union uses money as a unit of account and as a medium of exchange. As a unit of account, Soviet monies are imperfect, but adequate. This is so because the prices with which goods are aggregated do not accurately reflect resource costs. As a medium of exchange,

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[23]Progressive, proportional, and regressive taxes are those for which the marginal tax rate exceeds, is equal to, and is exceeded by the average tax rate, respectively.

Soviet bank deposit money does the job, but settlements are slow and complex. Soviet banking differs greatly from its capitalist counterpart.

Prices are used to plan, to allocate resources, and to determine income. Conditions necessary to fulfill the first two functions inherently conflict (stable prices and scarcity prices, respectively). Price and tax policy are used in conjunction to accomplish the three aims of the last function. Through price setting and taxation, the Soviets attempt t- equate net disposable money income with aggregate value of purchased goods and services, to equate supply and demand for each individual commodity, and to partially equalize the distribution of real income.

In addition to their role in income determination, taxes are used to raise the revenues necessary for the state to function. The Soviet government budget has had a surplus every year since World War II. It will be shown in the next section that the Soviet state budget imposes a massive burden on the economy.

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Comparison of Taxes in the United States
and the Soviet Union
</div>

This section contrasts the tax structure and the burden of taxes in the United States and the Soviet Union, and the burden of taxes in the respective countries.

The United States Tax Structure

The following diagram shows the approximate contribution to total federal budget receipts in 1977 of the major receipt sources.

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      3/7                1/7        2/7        1/7
  ┌────────────────────┬───────┬────────────┬───────┐
  │         A          │   B   │     C      │   D   │
  └────────────────────┴───────┴────────────┴───────┘
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A -- Individual income taxes

B -- Corporate income taxes

C -- Social insurance taxes and contributions

D -- Excise taxes
     Estate and gift taxes
     Customs duties
     Miscellaneous receipts:
         Deposits of earnings by Federal Reserve System
         All other

The largest federal revenue source, the individual income tax, is highly progressive. The following are the main features of the tax as it has applied to the income after deductions of single individuals since 1973:

Annual Income	Marginal Tax Rate (percent)
$0 - $500	0
$500 +	14+
.	
$100,000	70 (unearned income) (Wanniski, 1978)

Federal tax receipts in 1977 accounted for a little less than 63 percent of total government receipts ($343.9 billion out of $600.8 billion). (U.S. President, 1978)

State and local tax receipts in 1977 accounted for a little more than 37 percent of total government revenues ($226.9 billion) (excluding federal grants-in-aid). (U.S. President, 1978) The following diagram shows the approximate breadkown of these tax receipts.

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(U.S President, 1978)

2/10	2/10	1/10	1/10	2/10	2/10
A	B	C	D	E	F

A -- Property taxes

B -- Sales and gross receipts taxes

C -- Individual income taxes

D -- Corporation net income taxes

E -- Revenue from Federal Government

F -- All others

The Burden of American Taxes

Total U.S. government tax receipts are highly significant.
Federal taxes alone equal about 16 percent of gross national product
and 22 percent of all personal income received. Furthermore, outlays
usually exceed current tax receipts. Deficit financing commits the
government to levying future taxes to pay off current deficits. The
government discourages and encourages consumption of various goods by
taxing them or subsidizing them. The overall tax burden in the United
States is substantial, and the economic incentives of corporations and
individuals are reduced as a result.

U.S. and Soviet Taxes Compared

For this comparison the definition of tax burden which includes
business profits will be used. The size of the burden may be expressed
relative to total money incomes, as the average rate of taxation. The
average tax rate in the United States is significantly lower than in

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the United States is significantly lower than in the Soviet Union. In 1940, the rates were 27 percent in the U.S., and 56.8 percent in the Soviet Union. In 1949, the rates were 36.5 percent and 68.7 percent, respectively. This relative difference is maintained in later years.

While Soviet taxes are roughly proportional, U.S. taxes are highly progressive. The lack of progressivity in Soviet tax rates tends to reduce the incentive impact of taxes. Extremely high marginal tax rates in the U.S. severely reduce incentives.

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